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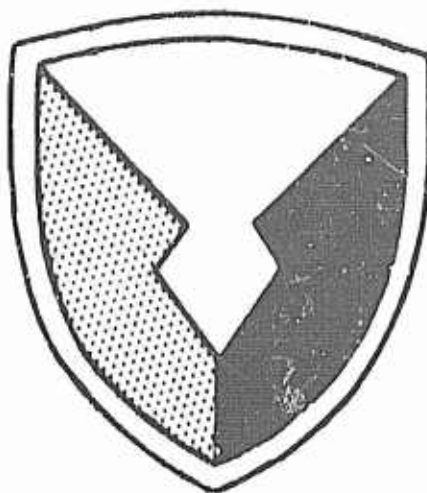
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**TEST & EVALUATION COMMAND**



JUN 28 1965

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USATECOM PROJECT NO. 6-3-6711-03

FINAL REPORT OF THE  
AIRWORTHINESS CERTIFICATION TEST OF THE  
QRC-160-1 INSTALLED ON THE  
OV-1C AIRPLANE

JANUARY 1965

HEADQUARTERS  
U.S. ARMY AVIATION TEST ACTIVITY  
EDWARDS AFB, CALIFORNIA



DEPARTMENT OF THE ARMY  
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND  
ABERDEEN PROVING GROUND, MARYLAND 21005

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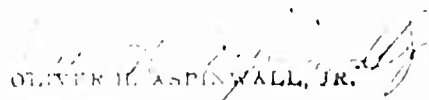
19 MAY 1965

SUBJECT: Final Report of the Airworthiness Certification Test of the  
QRC-160-1 Installed on the OV-1C Airplane, USATECOM Project  
No. 6-3-6711-03

TO: Commanding Officer  
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Subject report has been forwarded to the Mohawk Project Manager  
for information and retention.

FOR THE COMMANDER:

  
OLIVER H. ASPINWALL, JR.  
Capt, AGC  
Asst Admin Officer

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FINAL REPORT OF THE  
AIRWORTHINESS CERTIFICATION OF THE  
QRC-160-1 INSTALLED ON THE OV-1C AIRPLANE

DA PROJECT NO. 1-G-6-41212-D-540

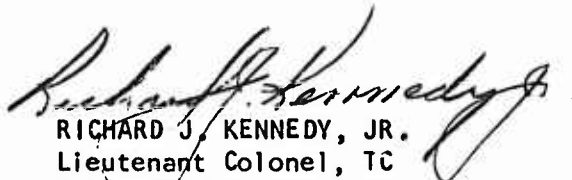
USATECOM PROJECT NO. 6-3-6711-03

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## ABSTRACT

An engineering flight evaluation to provide an Airworthiness Certification of the OV-1C airplane equipped with the QRC-160-1 Electronic Countermeasure (ECM) was conducted by the U. S. Army Aviation Test Activity (USAATA) at Edwards Air Force Base, California. A total of 35 flight hours was flown during this evaluation between 4 January 1964 and 24 January 1964.

Recommendation for Airworthiness Certification was issued by the USAATA in Message STEAV-E 29-1-65, 30 January 1964 (Reference 1.1.c).

The QRC-160-1 is an ECM External Store weighing 195 pounds used for the protection of aircraft. For this test, the installation was mounted at the drop tank station on the left wing of the OV-1C.

The QRC-160-1 can be employed with safety when mounted on the left wing of the OV-1C with either a full or an empty 150-gallon drop tank mounted on the right wing provided that a restricted flight envelope is observed.

The results of this evaluation concurred with the recommendation by the Naval Air Test Center of an airplane center-of-gravity (C.G.) limit of 30 percent mean aerodynamic chord (MAC) rather than the Operators' Manual limit of 33 percent MAC.

Additional testing should be conducted to determine whether the lateral-directional problems uncovered during this program are inherent characteristics of OV-1C aircraft.

The Operators' Manual for the OV-1C should be updated to include single-engine performance and minimum control speeds at altitudes above sea level.

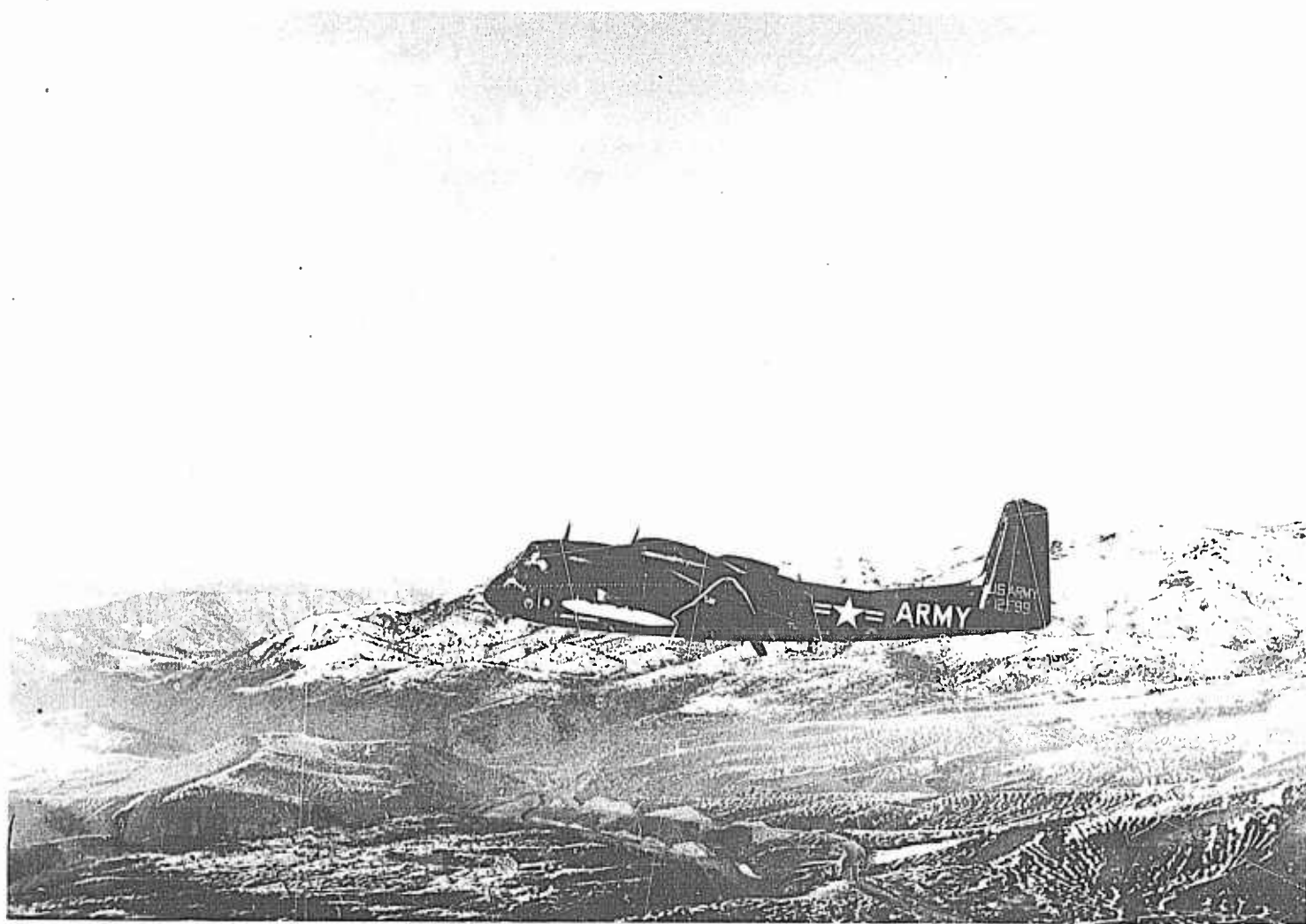


Photo 1 - Mohawk OV-10

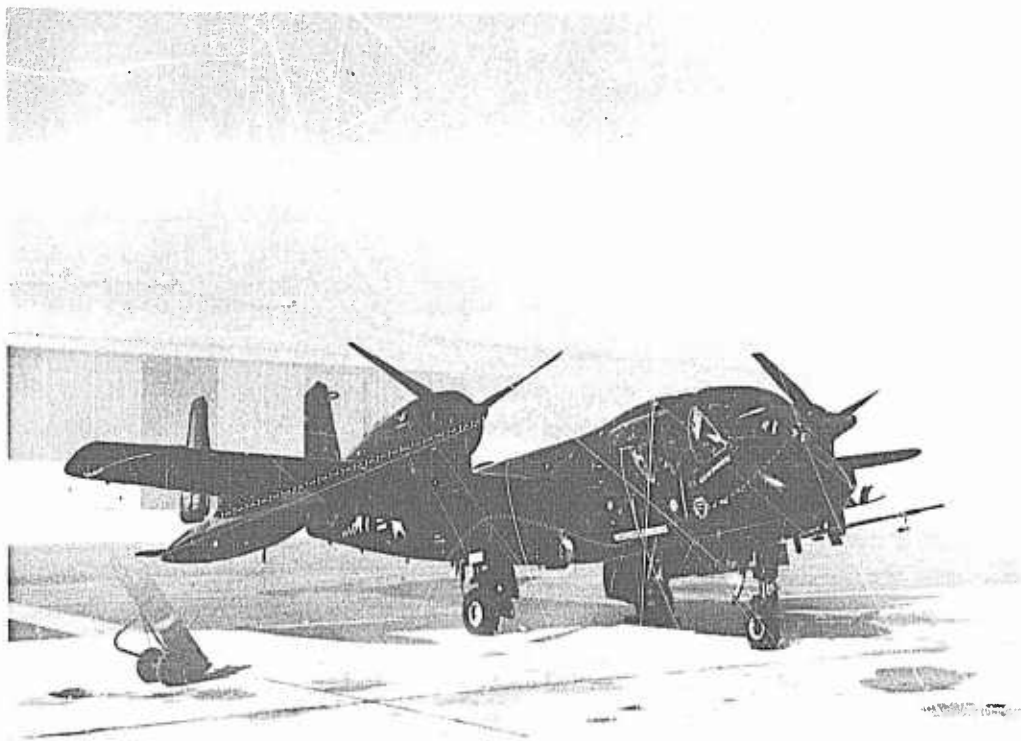


Photo 2 - Mohawk OV-1C

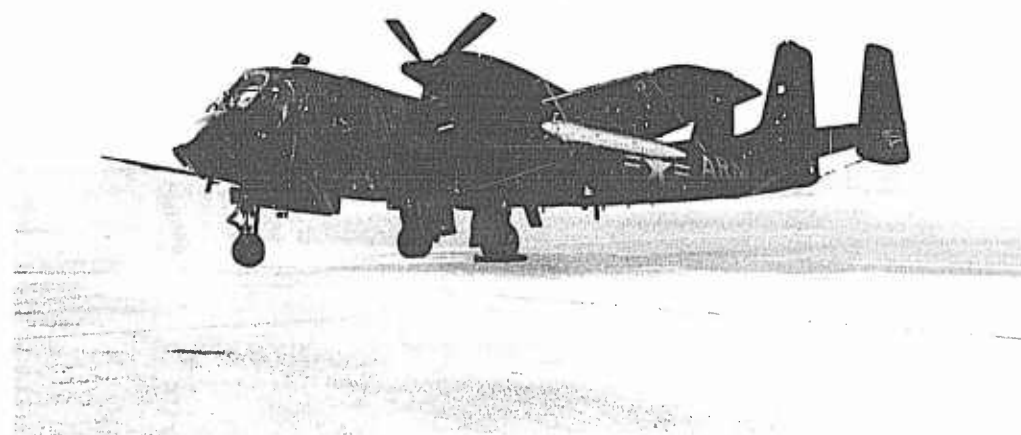


Photo 3 - Mohawk OV-1C

## SECTION 1 - GENERAL

### 1.1 REFERENCES

- a. Message TT18468, AMSTE-EL, Headquarters, U. S. Army Test and Evaluation Command (USATECOM), 2 November 1963, subject: Military Potential Test of Electronic Countermeasure (ECM) Equipment QRC-160-1.
- b. Message TT19199, AMSTE-EL, Headquarters, USATECOM, 15 November 1963, subject: Flight Certification Tests of the QRC-160-1 Installed on the OV-1C Airplane.
- c. Message STEAV-E 29-1-65, U. S. Army Aviation Test Activity (USAATA), 30 January 1964, subject: Flight Release of the OV-1C with the QRC-160-1 External Store Installed.
- d. AFFTC-TN-59-21, 'AFFTC Stability and Control Techniques,' U.S. Air Force Flight Test Center (AFFTC), May 1959.
- e. Military Specification MIL-F-8785 (ASG), 'Flying Qualities of Piloted Airplanes,' 1 September 1954.
- f. Technical Manual TM-55-1510-204-10, 'Operators' and Crew Members' Manual, Army Models OV-1A, OV-1B and OV-1C Aircraft,' Department of the Army, May 1963.
- g. Report No. 1, NATC BIS 21238, 'Combined Stability and Control and Aircraft and Engine Performance Trials of the Model YAQ-1 Airplane,' U.S. Naval Air Test Center, 11 August 1960.
- h. Military Specification MIL-I-6115A, 'Installation of Instrument Systems, Pitot Tube Flush Static Post Operated,' 31 December 1960.
- i. AFFTC-TR-6273, 'Flight Test Engineering Manual,' AFFTC, May 1951.

### 1.2 AUTHORITY

- a. Message TT18468, AMSTE-EL, Headquarters, USATECOM, 2 November 1963, subject: Military Potential Test of Electronic Countermeasure (ECM) Equipment QRC-160-1 (Reference 1.1.a).
- b. Message TT19199, AMSTE-EL, Headquarters, USATECOM, 15 November 1963, subject: Flight Certification Tests of the QRC-160-1 Installed on the OV-1C Airplane (Reference 1.1.b).

### 1.3 TEST OBJECTIVES

The objective of this test was to provide a recommendation for Airworthiness Certification of the ECM QRC-160-1 installed on the OV-1C airplane for the Military Potential Test of the System.

### 1.4 RESPONSIBILITIES

The USAATA was assigned as Participating Test Authority in the Military Potential Test of the ECM QRC-160-1 installed on the OV-1C airplane and as such its specific responsibility was to conduct Airworthiness Certification Tests for the test program.

### 1.5 DESCRIPTION OF MATERIEL

#### 1.5.1 PHYSICAL CHARACTERISTICS OF THE QRC-160-1

The only characteristics of the QRC-160-1 pertinent to this evaluation (i.e., factors influencing flying qualities) were its weight and dimensions. The QRC-160-1 mounted on the left wing Aero 65A rack of the OV-1C is shown in Photographs 1 and 2 (Pages vi and vii). The QRC-160-1 mounted at this station did not interfere with normal operation of the flight controls.

The pertinent physical characteristics of the QRC-160-1 are as follows:

- |  |                            |
|--|----------------------------|
| a. Weight  | 195 lb                     |
| b. Mass Moment of Inertia<br>about Center of Gravity<br>(C.G.) | 72,810 lb/in. <sup>2</sup> |
| c. Length  | 93 in.                     |
| d. Diameter  | 10.5 in.                   |

#### 1.5.2 PHYSICAL CHARACTERISTICS OF THE OV-1C

The QRC-160-1 was installed on a standard production OV-1C. The OV-1C is a two-place, twin-engine turboprop airplane, designed to operate from small, unimproved fields for purposes of tactical observation. The airplane is a tricycle-gear, mid-wing, tri-tail type with engine nacelles mounted on top of the wings. The primary flight controls are unboosted and are operated by mechanical linkages with the exception of hydraulically boosted inboard ailerons that actuate with the outboard ailerons whenever the flaps are extended. The airplane is powered by two Lycoming T53-L-3 engines rated at 1005 engine shaft horsepower (ESHP) each.

The pertinent dimensions of the OV-1C are as follows:

a. Wing Span	42 ft.
b. Wing Area	330 ft <sup>2</sup>
c. Maximum Length	41 ft
d. Static Wheel Base	11.7 ft.
e. Vertical Tail Height	12.7 ft.

#### i.5.2.1 Control Surfaces of the OV-1C

Pertinent details concerning control surfaces of the OV-1C are as follows:

<u>Control Surface</u>	<u>Deflection</u>
Elevator	25 deg Trailing Edge UP (TEU) to 15 deg Trailing Edge Down (TED)
Elevator Trim Tab	7 deg TEU to 5 deg TED
Aileron (Outboard)	25 deg TEU to 25 deg TED
Aileron Spring Tab	15 deg TEU to 15 deg TED
Aileron Trim Tab	15 deg TEU to 15 deg TED
Aileron (Inboard)	45 deg TEU from a 23 deg TED position No Down travel
Rudders	25 deg Right to 25 deg Left
Combination Trim and Geared Leading Tab on the Center Rudder	Trim tab travel 17 deg Right and 18 deg Left with zero rudder deflection. Geared leading tab (nonlinear) with a maximum deflection of 10 deg Right and 12 deg Left with neutral trim tab setting.
Wing Flaps	Takeoff 15 deg Down Landing 45 deg Down
Wing Slats	10 percent chord movement Forward and 6 percent chord movement Down
Speed Brakes	0 deg or 60 deg

## 1.6 BACKGROUND

The U. S. Army Electronic Proving Ground (USAEPG) was directed to conduct a Military Potential Test on the QRC-160-1 ECM installed on the OV-1C airplane. Prior to testing, Airworthiness Certification for the system was required. The USAATA was directed to perform such tests as were necessary for the Project Manager to issue an Airworthiness Certification.

An OV-1C airplane, Serial Number 61-2699, was delivered to the USAATA on 22 November 1963. Instrumentation was accomplished. The first flight was conducted on 4 January 1964 and the airplane was delivered to the USAEPG at Fort Huachuca, Arizona, on 28 January 1964, for continuation of the QRC-160-1 Military Potential Test.

Recommendation for Airworthiness Certification was issued by the USAATA in Message STEAV-E 29-1-65, 30 January 1964 (Reference 1.1.c).

## 1.7 FINDINGS

### 1.7.1 GENERAL

The philosophy employed in this evaluation was to test the QRC-160-1 installation thoroughly in one configuration inasmuch as time considerations precluded the development of a complete flight envelope. With this objective in mind, the decision was made to test the airplane with the QRC-160-1 on the left wing and a full fuel drop tank on the right wing. This configuration was considered to be the most useful for the Military Potential Test of the system and the most critical from a stability-and-control viewpoint. Qualitative stability and control tests with the QRC-160-1 on the left wing and no external stores on the right wing verified this assumption. Unless otherwise stated, therefore, all tests and plots refer to the configuration of the QRC-160-1 on the left wing and a full fuel drop tank on the right wing.

Flight tests were conducted at an average density altitude of 7500 feet for all tests except the single-engine tests, which were conducted at a density altitude of 5000 feet. The average takeoff gross weight for these tests was approximately 14,300 pounds and takeoff C.G. ranged between 23.3 percent mean aerodynamic chord (MAC) and 29.4 percent MAC.

All flight tests were conducted using the flight test procedures and reduction techniques outlined in Reference 1.1.d.

No jettison tests were performed during this evaluation; therefore, if the system is adopted for general Army use, jettison tests as well as tests to expand the flight envelope should be conducted. Until additional

tests are conducted, the QRC-160-1 should be limited to the left wing external store station with no other external store installed than a drop tank on the right wing.

The standard of comparison used in this evaluation was MIL-F-8785 (ASG), "Flying Qualities of Piloted Airplanes," (Reference 1.1.e).

The following abbreviations are used throughout the report when referring to the various airplane configurations tested:

TABLE 1. ABBREVIATIONS FOR TESTED CONFIGURATIONS

Condition	Symbol	Trim Airspeed	Flaps	Landing Gear
Takeoff	TO	1.30 $V_{stall}$	15°	Down
Power-Approach	PA	1.15 $V_{stall}$	45°	Down
Cruise (Clean)	CR	177 kts CAS	Up	Up
Level Flight at Normal Rated Power	NRP	Velocity for Normal Rated Power	Up	Up

#### 1.7.2 TAXIING, TAKEOFF AND INITIAL CLIMB

The airplane could be taxied with any amount of fuel in the right drop tank and with either or both engines unfeathered. The wheel brakes were effective for directional control and had to be used extensively when both engines were unfeathered. Asymmetric power for directional control was hazardous; and high yaw rates were encountered, particularly when returning from reverse thrust to forward thrust at high power. The rapid brake applications required to overcome these yaw rates will cause excessive tire wear. Feathering one engine during taxiing permitted slower taxi speeds and subsequently less brake wear. Taxiing in a direct crosswind of 15 knots was satisfactory with either engine feathered.

Control trim settings recommended in the Operators' Manual (Reference 1.1.f) for takeoff (2 degrees up elevator, 5 degrees right aileron and 5 degrees right rudder) were adequate with the QRC-160-1 installed on the left wing when the right fuel drop tank was either empty or off

the airplane. Recommended trim settings to be used when the right drop tank is full are 0 degrees elevator, full-left aileron and 5 degrees right rudder.

Zero-degree flap takeoffs were found to be more critical than 15-degree flap takeoffs because of the decreased lateral control power available when the inboard ailerons were inoperative. No short takeoff and landing (STOL) takeoffs were conducted during this evaluation, and it is recommended that no STOL takeoffs be conducted until further testing of the OV-1C with the QRC-160-1 is accomplished. (Paragraph 1.9.1.a)

Lift-off speed with the right drop tank full was determined by recommended single-engine speed. Lift-off should be accomplished at 110 knots indicated airspeed (KIAS) and flaps should not be raised until the airplane has accelerated to 120 KIAS, the recommended single-engine speed.

Limited asymmetric power flight characteristics were evaluated. Flight conditions and airplane configurations were chosen that would be typical of those encountered during the Military Potential Test at the U. S. Army Electronic Proving Ground. Tests were conducted in the takeoff and the cruise configurations with the QRC-160-1 pod on the left wing and both a full drop tank on the right wing and no drop tank on the right wing. The minimum control speeds are summarized in Table 2.

TABLE 2 (See next page)

TABLE 2. MINIMUM CONTROL SPEEDS FOR TAKEOFF AND CRUISE CONFIGURATIONS

Airplane Config- uration	External Store Config- uration	Left Engine Out Speed of Minimum Control - KIAS		Right Engine Out Speed of Minimum Control - KIAS	
		Propeller Windmilling	Propeller Feathered	Propeller Windmilling	Propeller Feathered
CR	QRC-160-1 left wing No store right wing	98	98	88	88
CR	QRC-160-1 left wing Full drop tank right wing	101	96	112	117
TO	QRC-160-1 left wing No store right wing	80	80	78	78
TO	QRC-160-1 left wing Full drop tank right wing	83	80	100	90

Loss of the left engine was more critical than loss of the right engine with the QRC-160-1 installed and no drop tank on the right wing. A positive rate of climb could be maintained at a gross weight of 12,500 pounds and a density altitude of 4000 feet. The minimum control speeds for both the propeller feathered and windmilling with the left engine out were 98 KIAS in the cruise configuration and 80 KIAS in the takeoff configuration. The minimum control speed was limited by aerodynamic stall, high right pedal forces (135 pounds) and lateral control available. A pedal force of 135 pounds is less than the 180-pound limit specified in MIL-F-8785 (ASG), paragraph 3.4.12; however, in the latter case, with full lateral control applied, the pedal becomes the primary control to keep the wings level and this cannot be satisfactorily accomplished while holding a force of 135 pounds. The same comment applies in the following discussions. The control stick oscillated laterally against the stops at the minimum control speed. The right engine-out minimum control speeds with the propeller both feathered and windmilling were 88 KIAS in the cruise configuration and 78 KIAS in the takeoff configuration. The minimum control speed was limited by

aerodynamic stall, left lateral control available and high left pedal forces (55 pounds cruise and 100 pounds in the takeoff configuration).

Loss of the right engine was more critical than loss of the left engine with the QRC-160-1 pod on the left wing and a full drop tank on the right wing. Tests were conducted at an average gross weight of 13,500 pounds and a density altitude of 5000 feet. The right engine-out propeller-feathered minimum control speed was 117 KIAS in the cruise configuration (limited by left lateral control available) and 90 KIAS in the takeoff configuration (limited by left lateral control available and high left pedal forces). With the right propeller windmilling, the minimum control speed was 112 KIAS in the cruise configuration (limited by left lateral control available) and 100 KIAS in the takeoff configuration (limited by high left pedal forces). The best climb performance appeared to be in the cruise configuration at approximately 120 KIAS. The left engine-out minimum control speed in the takeoff configuration was 80 KIAS with the propeller feathered and 83 KIAS with the propeller windmilling. The minimum control speed was determined by aerodynamic stall. The cruise configuration minimum control speed was 96 KIAS with the left propeller feathered and 101 KIAS with the propeller windmilling. The best climb performance appeared to be in the cruise configuration at 120 KIAS. As will be noted in the paragraph on stalls (1.7.9), stalls in the cruise configuration were preceded by an approximately 10-knot stall warning buffet. With the left engine out and the propeller windmilling, however, no warning preceded the stall.

Single-engine performance at a gross weight of 13,500 pounds and a density altitude of 5000 feet was marginal with the QRC-160-1 on the left wing and a full drop tank on the right wing. The Operators' Manual (Reference 1.1.f) for the OV-1C should be updated to include single-engine performance and minimum control speeds at altitudes to service ceiling. (Paragraph 1.9.3)

### 1.7.3 STATIC LONGITUDINAL STABILITY

The static longitudinal stability, both stick-fixed and stick-free, was evaluated at C.G. positions of approximately 23.3 percent MAC and 30 percent MAC for the takeoff, power-approach, cruise and maximum speed for level-flight trim conditions. All tests were conducted at an average density altitude of 7500 feet. The results of these tests are summarized in Figures No. 1 through 8, Section 3, Appendix 1.

The OV-1C in the configuration tested and within the C.G. range recommended in this report (30 percent MAC) meets the requirement of MIL-F-8785 (ASG) that the stick-free (paragraph 3.3.1) and stick-fixed (paragraph 3.3.2) neutral points be aft of the most aft C.G. under all flight conditions. The neutral points obtained are summarized in Table 3.

TABLE 3. STICK-FREE AND STICK-FIXED NEUTRAL POINTS UNDER TESTED FLIGHT CONDITIONS

Trim Condition	Stick-Fixed Neutral Point $N_0$ - percent MAC	Stick-Free Neutral Point $N'_0$ - percent MAC
PA	34	36.8
TO	38	41.5
CR	33	41.5
NRP	32.5	39.5

The aft C.G. limit for the OV-1C as recommended in the Operators' and Crew Members' Manual is 33 percent MAC. The Naval Air Test Center Stability and Control Evaluation (Reference 1.1.g) recommended that the aft C.G. limit should be set at 30 percent MAC. The limited results of this evaluation indicate that the latter is a valid recommendation. As can be seen from the results in Table 3, stick-fixed neutral points for the cruise and maximum speed for level-flight trim points were forward of the Manual - recommended C.G. limit. On the basis of these tests and the limited testing accomplished, it is recommended that an aft C.G. limit of 30 percent MAC be observed with the QRC-160-1 installation. (Paragraph 1.9.1.b)

#### 1.7.4 MANEUVERING STABILITY

Maneuvering stability tests were conducted at both a forward and an aft C.G. using the steady-turn method. Tests were conducted in the cruise, takeoff and power-approach configurations. Turns were conducted at a constant airspeed while stabilizing at various load factors at varying altitudes. The results of these tests are presented in Figures No. 9 through 11, Section 3, Appendix 1.

The stick-force and elevator-position gradients as a function of normal load factor were in all cases positive. All configurations tested were limited by aerodynamic stall. At forward C.G.'s in the cruise configuration (i.e., forward of 26 percent MAC) as can be seen from Figure No. 10, the stick force per g was slightly higher than the maximum allowable specified in MIL-F-8785 (ASG), Paragraph 3.3.9.1. This was not considered objectionable. At an aft C.G. in the cruise configuration a condition occurred at the higher load factors that was

described by the pilot as "stick lightening." This is substantiated by test results presented in Figure No. 10 which show the slope of the stick force versus g curve decreasing at the higher g values. This decrease in gradient, however, was within the 50 percent of the average gradient allowed by MIL-F-8785 (ASG), Paragraph 3.3.9. This condition is acceptable at this C.G. but is indicative of the problems to be expected at more aft C.G.'s and previously reported in the Naval Air Test Center evaluation (Reference 1.1.g).

All maneuvering stability neutral points determined during this evaluation were aft of the most aft recommended C.G. (30 percent MAC) for operating with this system. Figure No. 9, however, shows a stick-free point neutral of 31.8 percent MAC, which is forward of the aft C.G. limit recommended by the Operators' and Crew Members' Manual (Reference 1.1.f). This reinforces the recommendation to limit the aft C.G. for OV-1C's to 30 percent MAC.

The results of this test indicated that the aft C.G. should be limited to 30 percent MAC when operating the OV-1C with the QRC-160-1 external store. (Paragraph 1.9.1.b)

#### 1.7.5 DYNAMIC LONGITUDINAL STABILITY

Tests were conducted at both forward and aft C.G.'s at a density altitude of 7500 feet to determine the characteristics of the dynamic longitudinal modes of motion of the OV-1C with the QRC-160-1 external store on the left wing and a full fuel drop tank on the right wing. The tests were conducted in the cruise, takeoff and power-approach configurations.

In the following discussion the short-period mode is the periodic motion of the airplane characterized by a change in angle of attack at an essentially constant airspeed. The period of this oscillation is a periodic motion of less than 4 seconds duration.

The short-period longitudinal mode of motion was investigated by abruptly displacing the longitudinal stick aft far enough from the trim condition to obtain an incremental acceleration of approximately  $1/2$  g. The control was then returned to the initial trim condition and the airplane response noted. The short-period response was essentially dead beat in all configurations tested.

The phugoid or long-period longitudinal mode was investigated by decreasing the airspeed from trim by approximately 10 knots, using the longitudinal control, and then returning the control to the trim position.

The phugoid oscillations in both the takeoff and power-approach configurations were lightly damped at the aft C.G. loading and

moderately damped at the forward C.G. loading. The oscillatory period was approximately 25 seconds. In the cruise configuration at the aft C.G. the oscillation was moderately damped, with heavy damping of the oscillation occurring at the forward C.G. The period at these oscillations was approximately 20 seconds.

The damping of the phugoid oscillation on the OV-1C in the configurations tested met the requirements of MIL-F-8785 (ASG), Paragraph 3.3.6, as there were no objectionable flight characteristics attributed to poor phugoid damping.

#### 1.7.6 STATIC LATERAL-DIRECTIONAL STABILITY

The static lateral-directional stability of the OV-1C with the QRC-160-1 external store installed was evaluated by analyzing the control positions and forces required to maintain steady, non-turning, constant-airspeed sideslips. Tests were conducted at both a forward and an aft C.G. in the takeoff, cruise and power-approach configurations. Results of these tests are summarized in Figures No. 12 through 17, Section 3, Appendix 1.

Weak control-free lateral-directional stability was exhibited by the OV-1C in the power-approach and takeoff configurations. No significant change in lateral-directional stability characteristics was observed between forward and aft C.G. locations for a given configuration and trim airspeed.

The power-approach and the landing configurations exhibited essentially the same stability characteristics. In left sideslips, the variation of rudder force with sideslip angles ( $\frac{dF_r}{d\beta}$ ) was essentially linear up to about 5 to 7.5 degrees of sideslip. From 7.5 to between 15 and 20 degrees of sideslip, little or no increase in force was required to increase sideslip angle (i.e.,  $\frac{dF_r}{d\beta}=0$ ). Between 15 and 20 degrees of left sideslip, a rudder force reversal (i.e.,  $\frac{dF_r}{d\beta} < 0$ ) occurred accompanied by both rudder and elevator buffet. In a right sideslip,  $\frac{dF_r}{d\beta}$  was linear to approximately 10 degrees of sideslip, at which point a rudder force reversal occurred. This reversal was accompanied by both rudder and elevator buffet. MIL-F-8785 (ASG), Paragraph 3.4.5, requires a linear variation of rudder force with sideslip angle up to 15 degrees of sideslip. Left sideslips were characterized by a nose-up pitching moment. These pitching moments increased quite rapidly at the higher sideslip angles at or near the points of rudder force reversal. MIL-F-8785 (ASG), Paragraph 3.3.20, requires that this longitudinal trim change not exceed 10 pounds pull or 3 pounds push. As can be seen from Figures No. 12 through 17, Section 3, Appendix 1, the longitudinal nose-up trim change in left sideslip

frequently exceeded the 3-pound specification requirement by as much as a factor of 3. Adequate dihedral effect as indicated by the aileron force required to hold a steady sideslip ( $\frac{dF_a}{d\beta}$ ) was present in a left sideslip, and near neutral dihedral effect ( $\frac{dF_a}{d\beta} = 0$ ) was present in a right sideslip. MIL-F-8785 (ASG), Paragraph 3.4.7, requires a positive dihedral effect. In the cruise configuration no objectionable control-free stability characteristics were apparent until pedal forces of over 200 pounds, which is higher than the MIL-F-8785 (ASG) requirement, were applied. At these higher pedal forces, there was a tendency for a force reversal. The dihedral effect remained positive and the longitudinal trim change was negligible at this configuration.

The control-fixed static lateral-directional stability was satisfactory in all configurations tested. Both the elevator and aileron positions as a function of sideslip were positive with no reversing tendencies. In right sideslips in all configurations tested there was a tendency for the control-fixed dihedral effect (i.e.,  $\frac{dF_a}{d\beta}$ ) to decrease, but it never approached zero. The rudder position versus sideslip was essentially linear to the limit sideslip angles in all configurations tested.

On the basis of these tests, it is recommended that notes concerning the problem areas mentioned be incorporated in the Operators' Manual for the OV-1C when the QRC-160-1 is installed. (Paragraph 1.9.1.c) It is also recommended that further tests be conducted on standard OV-1's to determine if the same problems exist. If present in all configurations, appropriate notations should be made in the Operators' and Crew Members' Manual. (Paragraph 1.9.2)

#### 1.7.7 DYNAMIC LATERAL-DIRECTIONAL STABILITY

The dynamic lateral-directional stability mode of motion was evaluated by noting the airplane's response to a release from a steady non-turning sideslip. Releases were accomplished by both rapidly neutralizing the pedals and by releasing the pedals. Tests were accomplished at both a forward C.G. (23 percent MAC) and an aft C.G. (29.5 percent MAC) in the power-approach, takeoff and cruise configurations.

The lateral-directional mode (i.e., Dutch Roll) was heavily damped in all configurations tested. All releases ended up in a slowly divergent spiral. No objectionable flight characteristics were attributed to the lateral-directional mode of motion.

#### 1.7.8 AILERON ROLLS

The rolling characteristics of the OV-1C were evaluated by observing the airplane response to pedal-fixed and coordinated aileron rolls. The tests were conducted by rolling from a bank in one direction through the level flight position to a corresponding bank in the opposite direction. The rolling performance was evaluated with the QRC-160-1 installed on the left wing and both an empty and a full fuel drop tank on the right wing. Tests were conducted in the cruise, takeoff and power-approach configurations. The rolling performance during coordinated aileron rolls is summarized in Figures No. 18 through 20, Section 3, Appendix I. The adverse yaw characteristics observed during pedal-fixed aileron rolls are summarized in Figures No. 21 through 23, Section 3, Appendix I. Representative aileron roll time histories are presented in Figures No. 24 through 27, Section 3, Appendix I.

The rolling performance of the OV-1C in the configurations tested met the rolling requirements of MIL-F-8785 (ASG), Paragraph 3.4.16, with the drop tank empty. The rolling performance in a left roll was poor with a full fuel load in the right drop tank. Figures No. 18 through 20, Section 3, Appendix I, show that the amount of left aileron required to trim the airplane laterally with a full right drop tank installed was approximately one-half the total available left lateral control. Because of this reduced lateral control, no abrupt lateral control displacements to the right or lateral control displacements past one-half available stick travel to the right should be attempted. The aileron forces required to meet the rolling requirements of MIL-F-8785 (ASG), Paragraph 3.4.16.3 (Reference 1.1.e), were excessive. The military specification allows a maximum aileron control input of 25 pounds, whereas the OV-1C required aileron forces on the order of 50 pounds to achieve specification rolling performance in all configurations tested.

The adverse yaw exhibited by the OV-1C was considerably in excess of the 15-degree maximum specified by MIL-F-8785 (ASG), Paragraph 3.4.9. This large adverse yaw coupled with its rather rapid onset made coordinating turns unacceptably difficult. Full 360-degree aileron rolls both right and left were successfully accomplished in the cruise configuration with the right drop tank both full and empty.

#### 1.7.9 STALLS

Stalls were investigated at both forward and aft C.G. loadings in both unaccelerated and accelerated flight. Configurations tested

included cruise, takeoff and power-approach. The stalling performance on the OV-1C with the QRC-160-1 installed is summarized in Figure No. 28, Section 3, Appendix 1. The calibrated airspeed at stall for several gross weights is shown in Table 4.

TABLE 4. CALIBRATED AIRSPEED IN STALL TESTS

Configuration	Calibrated Airspeed at Stall - Knots		
	11,000 lb	13,000 lb	15,000 lb
PA	64	69.5	74
TO	67.5	74	79
CR	77	84	90

There was little difference in the stalling characteristics of the OV-1C at the forward and aft C.G. loadings.

Stalls in the cruise configuration were characterized by a very noticeable buffet that occurred approximately 10 knots above the stall. Unaccelerated stalls in this configuration broke cleanly with no tendency to drop a wing. A time history of an unaccelerated stall in the cruise configuration is shown in Figure No. 30, Section 3, Appendix 1. Accelerated stalls did not tend to break clean but were characterized by a break, partial recovery, then another break. The airplane, during these stalls, tended to roll out of the turn.

Stalls in the takeoff and power-approach configurations were characterized by a clean breaking stall with no stall warning. Time histories of an accelerated and an unaccelerated stall in the power-approach configuration are depicted in Figures No. 31 and 32, Section 3, Appendix 1. Stalls with inadequate warning are especially dangerous on airplanes that must be operated near the stall to achieve STOL performance. In the takeoff and power-approach configurations the OV-1C did not meet the stall warning requirements of MIL-F-8785 (ASG), Paragraph 3.6.3. MIL-F-8785 (ASG) requires aircraft to have adequate stall warning. On the basis of these tests, it is recommended that an adequate stall warning device be incorporated on all OV-1C series airplanes. (Paragraph 1.9.4) It is further recommended that tests be conducted to determine the feasibility of using an angle-of-attack indicator on the OV-1C. (Paragraph 1.9.5)

Table 5 summarizes the maximum lift coefficients obtained during the stall investigations:

TABLE 5. MAXIMUM LIFT COEFFICIENTS DURING STALL TESTS

Configuration	Cl* Max @ Stall				Average Cl Max
	Unaccelerated Forward C.G.	Aft C.G.	Accelerated Forward C.G.	Aft C.G.	
Cruise	1.58	1.54	-	1.753	1.66
Takeoff	2.065	2.22	-	2.16	2.15
Power-Approach	2.50	2.47	-	2.30	2.42

\* Coefficient of Lift

#### 1.7.10 FINAL APPROACH AND LANDING

The final approach and landing with the QRC-160-1 on the left wing and no external fuel tank on the right wing of the OV-1C should be flown using the procedures and limitations outlined in the Operators' and Crew Members' Manual for the standard OV-1C (Reference 1.1.f).

The following additional limitations and recommendations should be observed when operating the OV-1C with the QRC-160-1 on the left wing and a full fuel drop tank on the right wing:

- a. No maximum performance landings were conducted during the evaluation and no such landings should be attempted until further testing is accomplished.
- b. The reduced available lateral control due to the asymmetric loading makes the use of flaps and the added lateral control power of the inboard ailerons advisable during landing.
- c. When landing with fuel in the right wing drop tank, the control stick trim position is to the left of center, making a right crosswind preferable to a left crosswind.

#### 1.7.11 AIRSPEED CALIBRATION

The boom and standard ship airspeed systems were calibrated for position error. Both a measured ground speed course and a pacer T-37 with a calibrated airspeed system were used for this test. The results of this test are presented in Figure No. 33, Section 3, Appendix 1.

The position error of the standard system is within the limits of MIL-1-6115A (Reference 1.1.h) in all cases except in the high-speed flaps-down cases in the power-approach and takeoff configurations in which the limit exceeded by approximately 1 knot.

#### 1.7.12 CONTROL BREAKOUT FORCES

The control breakout forces were measured in a closed hangar using a hand-held force gage.

Table 6 gives the results of this test:

TABLE 6. TEST RESULTS OF CONTROL BREAKOUT FORCES

	Elevator		Aileron		Rudder	
	Forward	Aft	Left	Right	Left	Right
	lb		lb		lb	
Measured OV-1C, S/N 61-2699	2	1.75	1.25	1.00	2.5	3.5
MIL-F-8785 (ASG) limits	Min -	0.5	Min -	0.5	Min -	1
	Max -	3.0	Max -	2	Max -	7

All breakout forces on the OV-1C were within the limits of MIL-F-8785 (ASG), Paragraph 3.2.1.1.

#### 1.7.13 MISCELLANEOUS TESTS

Wing tip accelerometers were installed on the test airplane to determine if the QRC-160-1 initiated any flutter tendencies. No flutter tendencies were observed during the test program. Dives were conducted to 300 KIAS during the evaluation, and prior to further testing, it is recommended that a 300-KIAS airspeed limit be observed on all OV-1C's with the QRC-160-1 installed. (Paragraph 1.9.1.d)

#### 1.8 CONCLUSIONS

The OV-1C with the QRC-160-1 External Store installed can be flown with safety provided that the limitations and procedures outlined in this report are thoroughly understood and observed by OV-1C pilots during the Military Potential Test.

Further testing (including jettison tests) will be required if the system is to be adopted for general service use.

The Operators' and Crew Members' Manual (Reference 1.1.f) should be updated to include single-engine performance and minimum control speeds at altitudes above sea level.

Additional testing should be conducted to determine whether the lateral-directional problems uncovered during this program are an inherent characteristic of OV-1C aircraft.

The OV-1C has inadequate stall warning in the takeoff and power-approach configurations.

#### 1.9 RECOMMENDATIONS

1.9.1 If the QRC-160-1 installation on the OV-1C is adopted for service use, jettison tests as well as tests to expand the flight envelope should be conducted. Until this is accomplished, no QRC-160-1 external store jettisons should be attempted and the following flight limitations and configurations, specified in this report, should be observed:

a. No STOL takeoffs should be attempted with the QRC-160-1 installed until further tests are conducted (Paragraph 1.7.2, Page 6 ).

b. An aft C.G. limit of 30 percent MAC should be observed with the QRC-160-1 installed (Paragraph 1.7.3, Page 9 ).

c. Pilots flying the OV-1C with the QRC-160-1 installed should be aware of the lateral-directional stability and control problems mentioned in the report (Paragraph 1.7.6, Page 12 ).

d. Prior to further tests an airspeed limit of 300 KIAS should be observed on OV-1C airplanes with the QRC-160-1 installed (Paragraph 1.7.13, Page 16 ).

1.9.2 Further tests should be conducted to determine if the lateral-directional problems observed during this test are characteristic of standard OV-1C's. If they are characteristic, appropriate notation should be inserted in the Operators' Manual (Paragraph 1.7.6, Page 12 ).

1.9.3 The OV-1C Operators' Manual should be updated to include single-engine performance and minimum control speeds at altitudes above sea level (Paragraph 1.7.2, Page 8 ).

1.9.4 An adequate stall warning system should be incorporated on all OV-1C airplanes (Paragraph 1.7.9, Page 14 ).

1.9.5 An angle-of-attack indicator should be evaluated on OV-1 series airplanes (Paragraph 1.7.9, Page 14 ).

## SECTION 2 -- DETAILS AND RESULTS OF TESTS

The information and details of test normally presented in this section are incorporated in Section 1.7, Findings.

SECTION 3 - APPENDICES

APPENDIX I - TEST DATA

FIGURE No. 1  
 STATIC LONGITUDINAL STABILITY  
 OV-1C SN 61-2635

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

SYMBOL	C.G. POSITION % MAC	GROSS Wt. LB.	ALTITUDE FT.	ELEVATOR TRIM TAB POSITION ~ DEG.
○	23.28 (FWD C.G.)	12680	7500	0.5° NOSE UP
□	29.80 (AFT C.G.)	13740	7500	0.6° NOSE UP

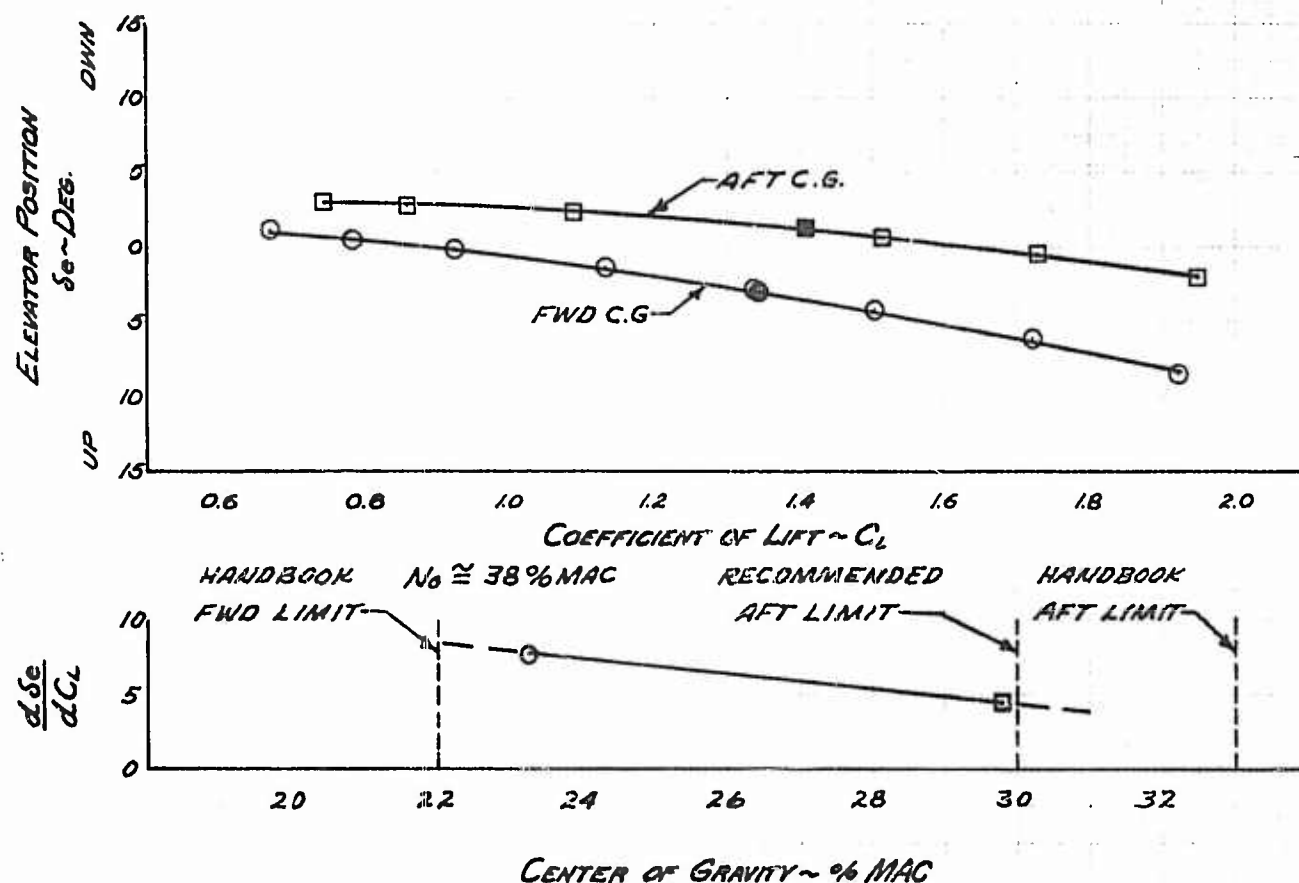
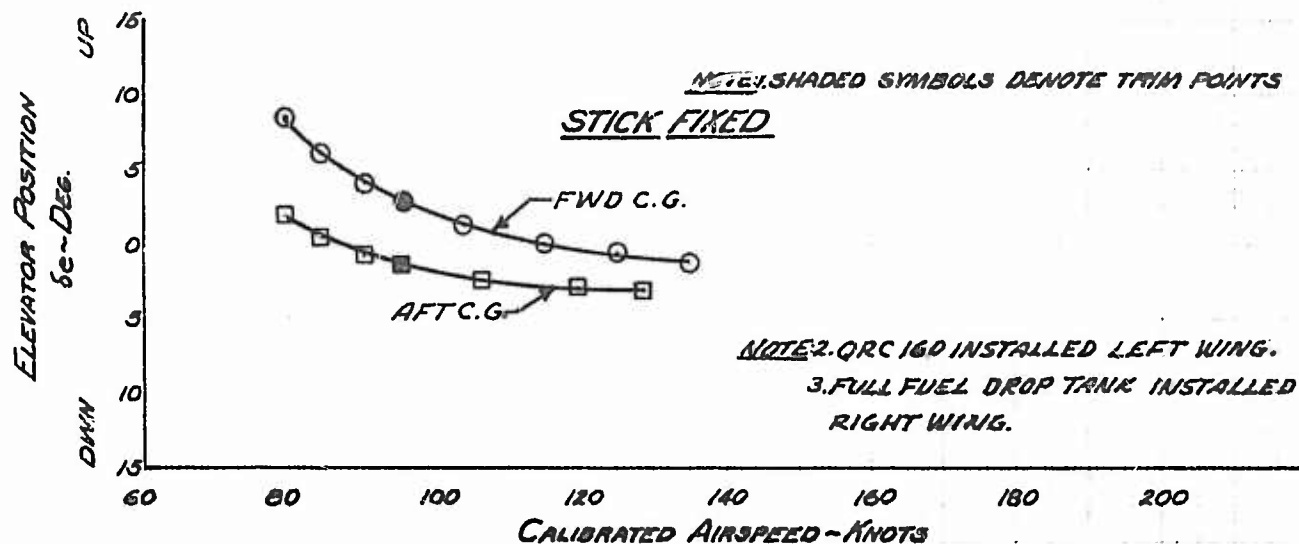


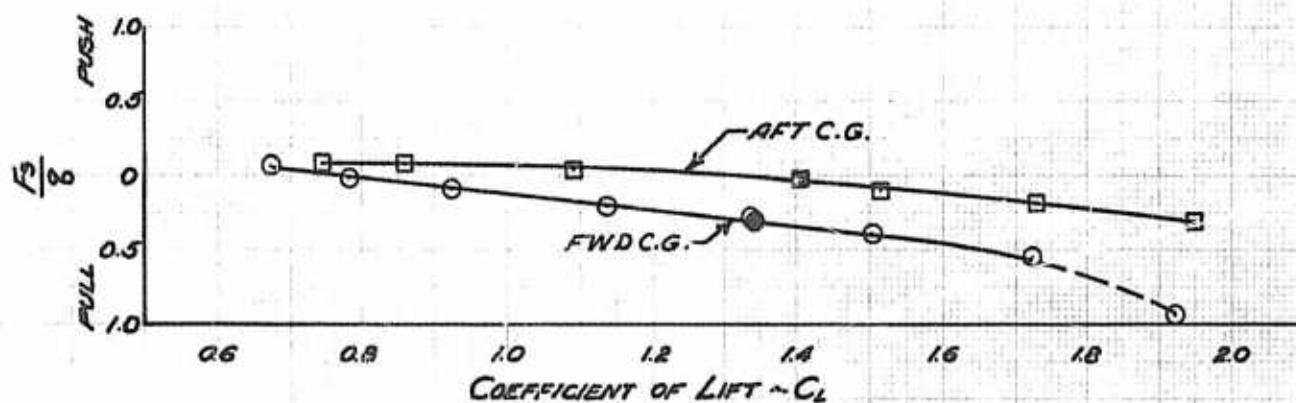
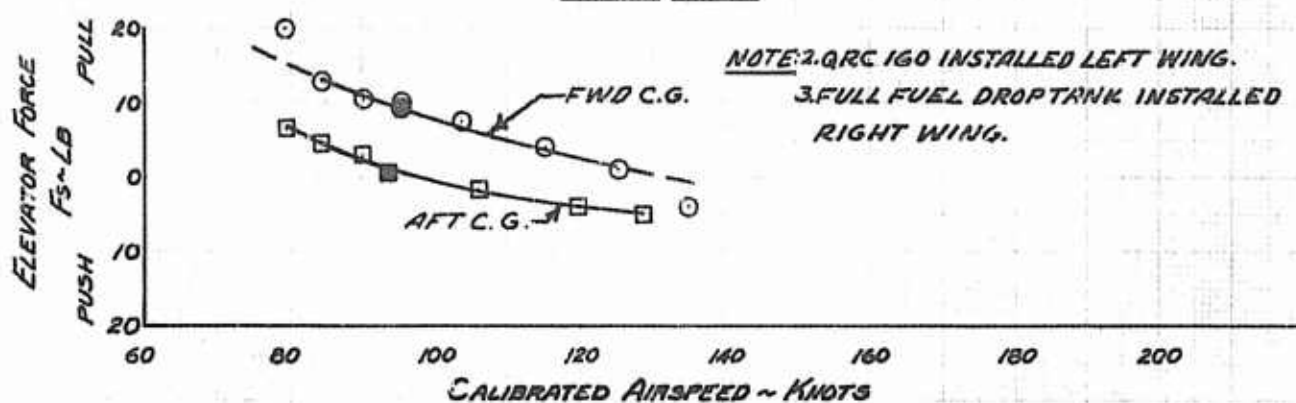
FIGURE NO. 2  
 STATIC LONGITUDINAL STABILITY  
 OV-1C SN 61-2699

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

SYMBOL	C.G. POSITION % MAC	GROSS Wt. LB.	ALTITUDE FT.	ELEVATOR TRIM TAB POSITION ~ DEG.
○	23.28 (FWD C.G.)	12680	7500	0.6° NOSE UP
□	29.80 (AFT C.G.)	13740	7500	0.6° NOSE UP

NOTE: SHADED SYMBOLS DENOTE TRIM POINTS

STICK FREE



$N_0' \cong 41.5\% \text{ MAC}$

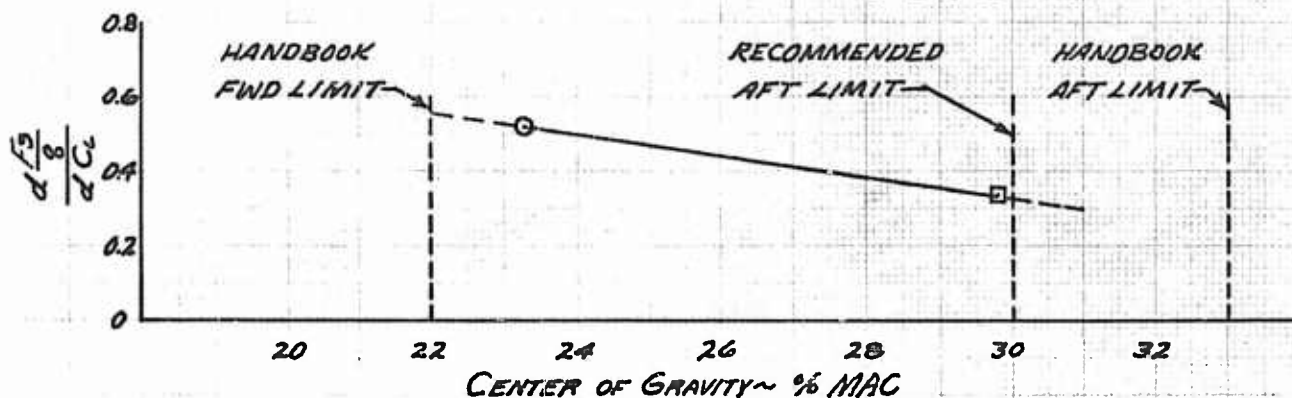


FIGURE No. 3  
 STATIC LONGITUDINAL STABILITY  
 OV-1C 4N 61-2699

CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT

SYMBOL	C.G. POSITION % MAC	GROSS WT. LB.	ALTITUDE FT.	ELEVATOR TRIM TAB POSITION ~ DEG.
○	23.30 (FWD C.G.)	12860	7500	1.5° NOSE DOWN
□	30.00 (AFT C.G.)	13580	7500	2.0° NOSE DOWN
◇	26.95 (MID C.G.)	13710	7500	1.9° NOSE DOWN

NOTE: SHADED SYMBOLS DENOTE TRIM POINTS

STICK FIXED

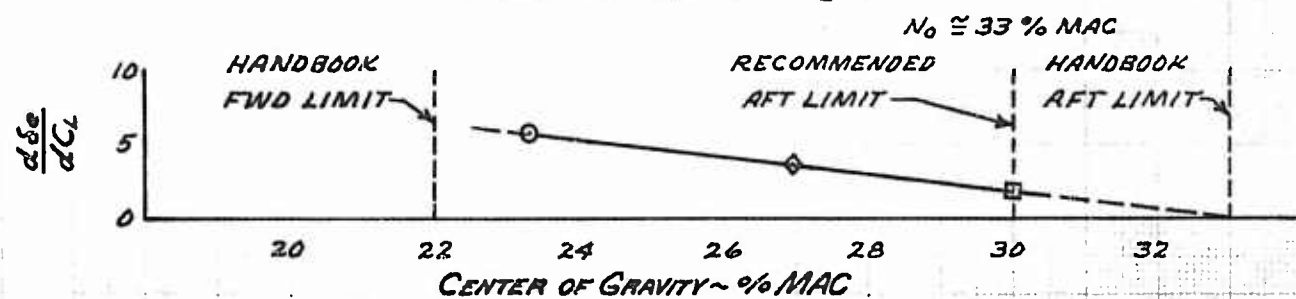
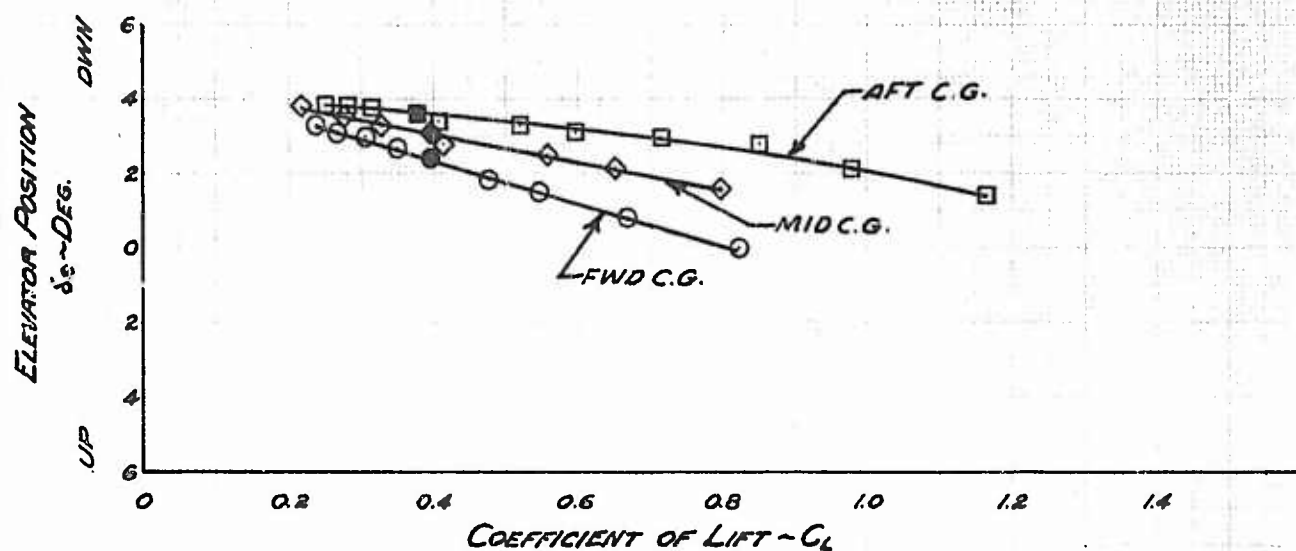
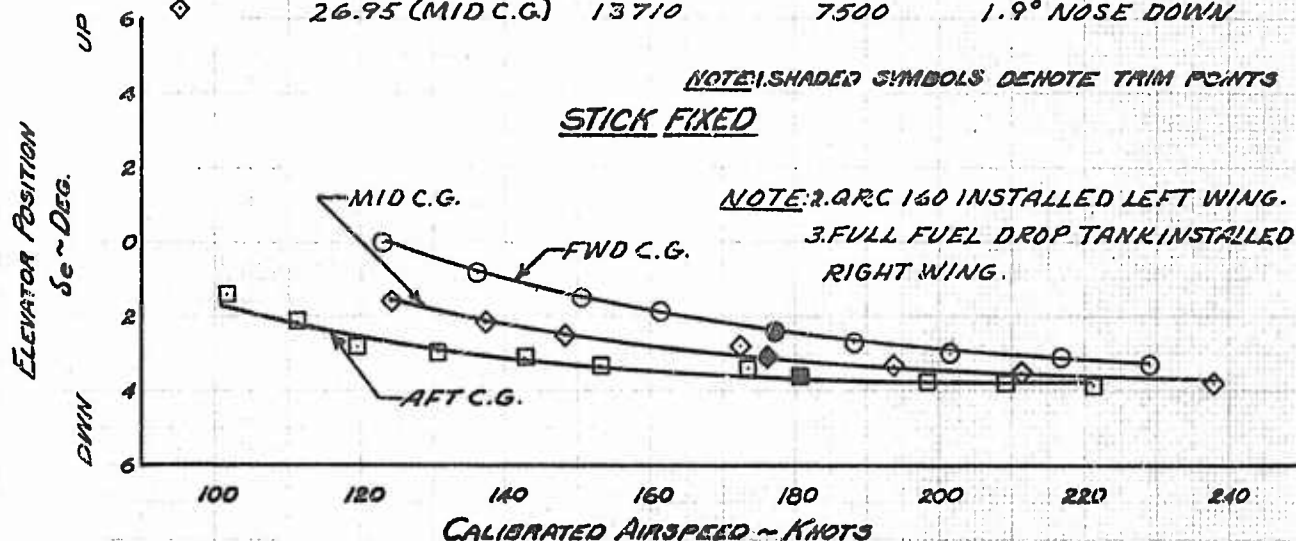


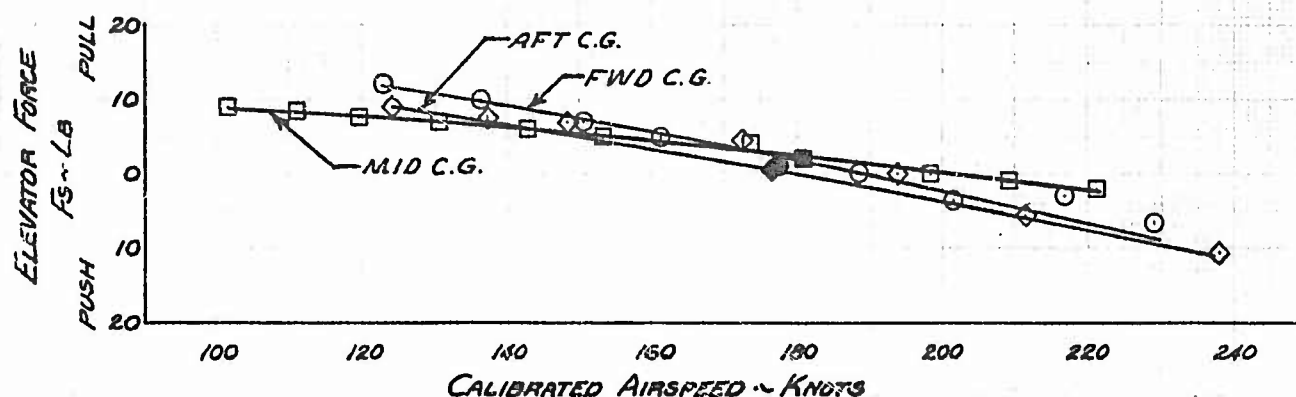
FIGURE NO. 4  
 STATIC LONGITUDINAL STABILITY  
 OV-1C 2/N 61-2699

CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT

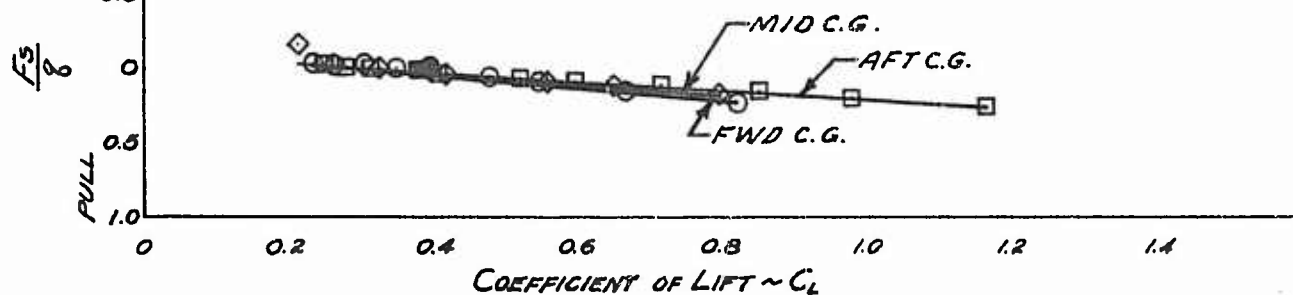
SYMBOL	C.G. POSITION % MAC	GROSS WT. LB.	ALTITUDE FT.	ELEVATOR TRIM TAB POSITION ~ DEG.
○	23.30 (FWD C.G.)	12860	7500	1.5° NOSE DOWN
□	30.00 (AFT C.G.)	13580	7500	2.0° NOSE DOWN
◇	26.95 (MID C.G.)	13910	7500	1.9° NOSE DOWN

NOTE 1. SHADED SYMBOLS DENOTE TRIM POINTS

STICK FREE



NOTE 2. QRC 160 INSTALLED LEFT WING.  
 3 FULL FUEL DROP TANK  
 INSTALLED RIGHT WING.



$N_0 \cong 41.5\% \text{ MAC}$

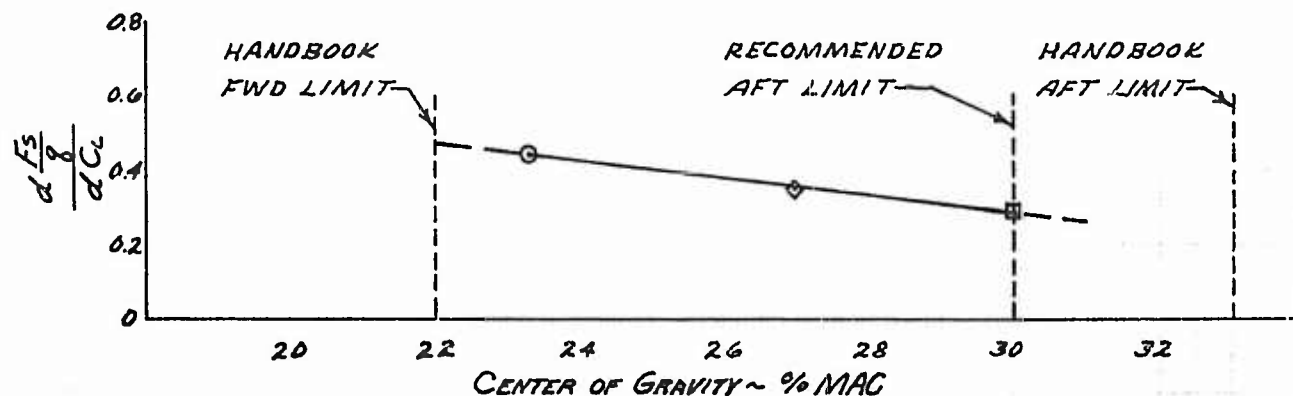
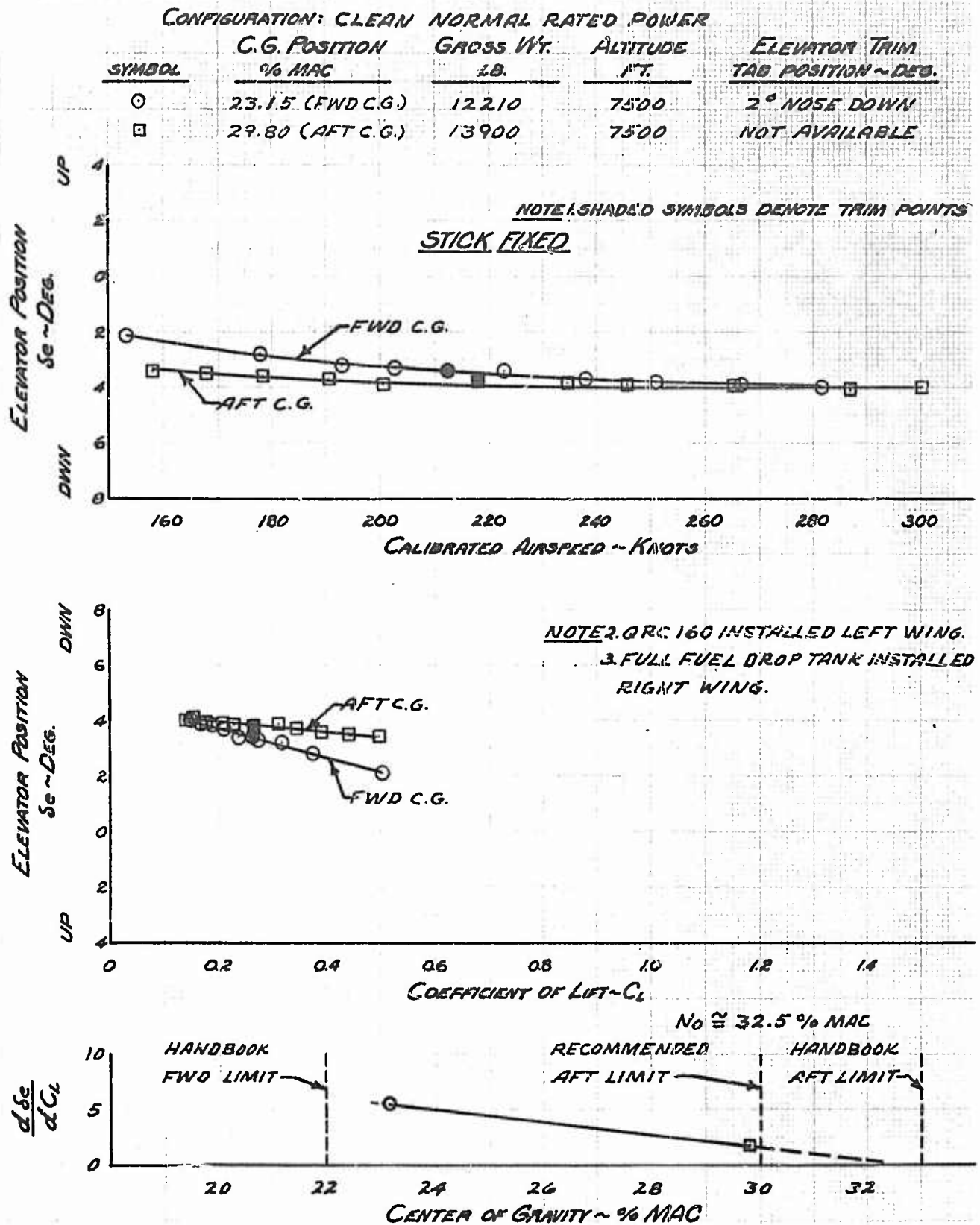


FIGURE No. 5  
 STATIC LONGITUDINAL STABILITY  
 OV-1C S/N 61-2699



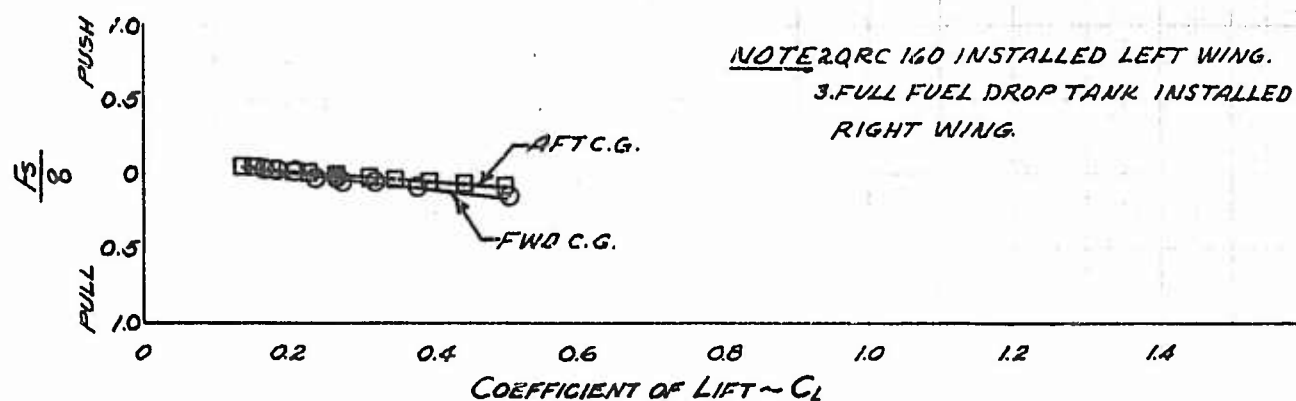
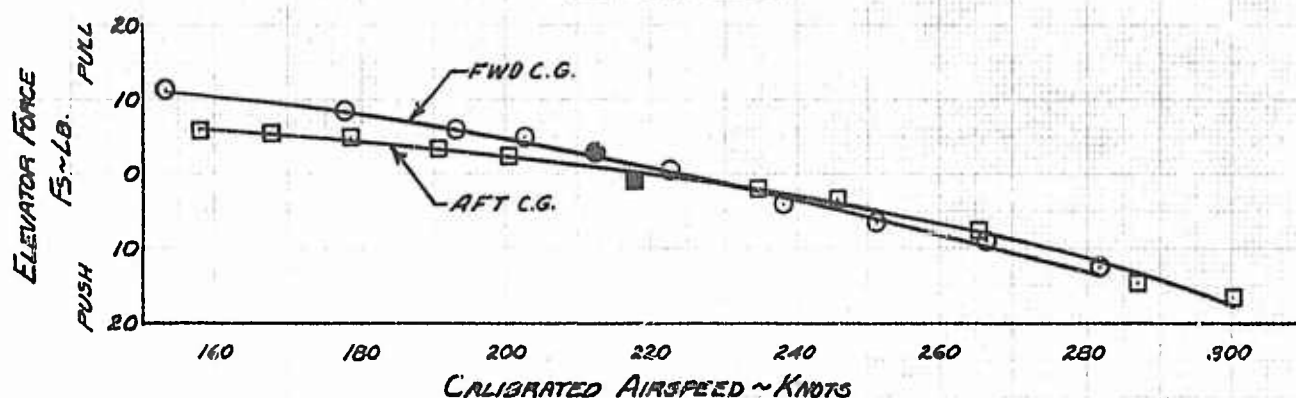
**FIGURE NO 6**  
**STATIC LONGITUDINAL STABILITY**  
**OV-1C S/N 61-2699**

**CONFIGURATION: CLEAN NORMAL RATED POWER**

<u>SYMBOL</u>	<u>C.G. POSITION</u> <u>% MAC</u>	<u>GROSS WT.</u> <u>LB.</u>	<u>ALTITUDE</u> <u>FT.</u>	<u>ELEVATOR TRIM</u> <u>TAB POSITION ~ DEG.</u>
○	23.15 (FWD C.G.)	12210	7500	2° NOSE DOWN
□	29.80 (AFT C.G.)	13900	7500	NOT AVAILABLE

*NOTE: SHADED SYMBOLS DENOTE TRIM POINTS*

**STICK FREE**



*NOTE: 2. QRC 160 INSTALLED LEFT WING.  
 3. FULL FUEL DROP TANK INSTALLED  
 RIGHT WING.*

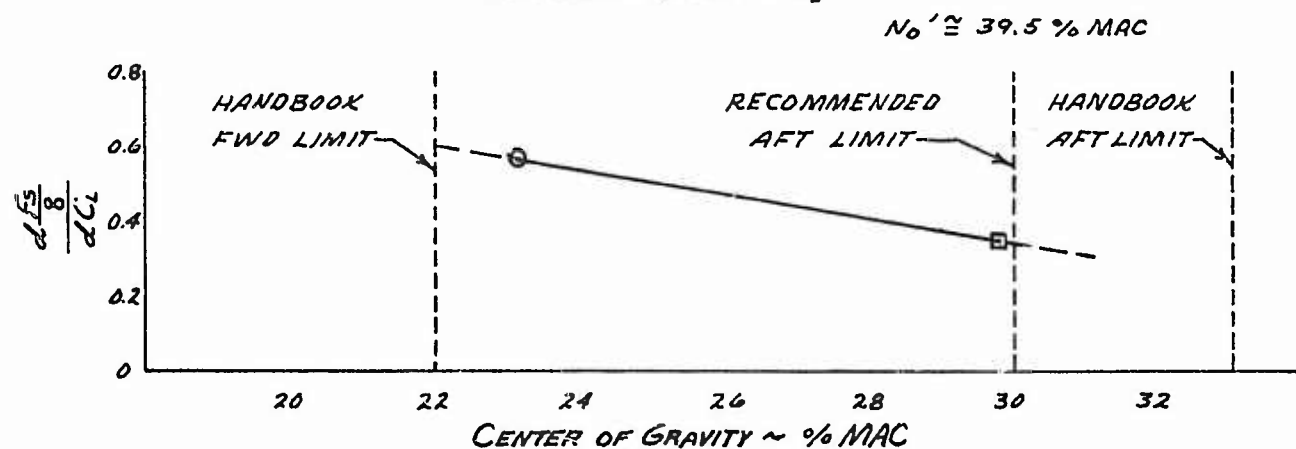


FIGURE No. 7  
 STATIC LONGITUDINAL STABILITY  
 OV-1C 9461-2699

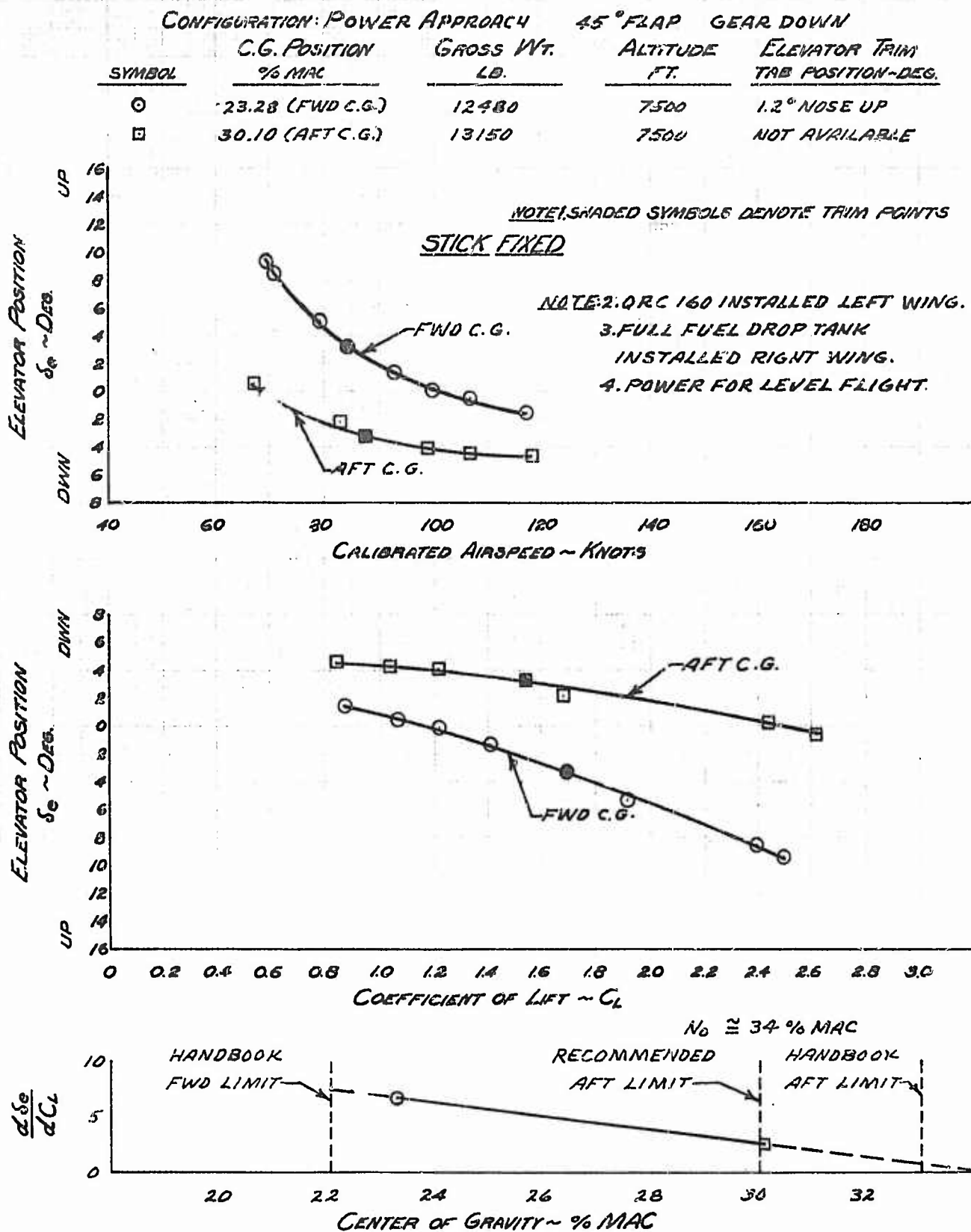


FIGURE NO 8  
 STATIC LONGITUDINAL STABILITY  
 OV-1C 5/N 61-2699

CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN				
SYMBOL	C.G. POSITION % MAC	GROSS WT. LB.	ALTITUDE FT.	ELEVATOR TRIM TAB POSITION ~ DEG.
○	23.28 (FWD C.G.)	12480	7500	1.2° NOSE UP
□	30.10 (AFT C.G.)	13150	7500	NOT AVAILABLE

NOTE: 1. SHADED SYMBOLS DENOTE TRIM POINTS

STICK FREE

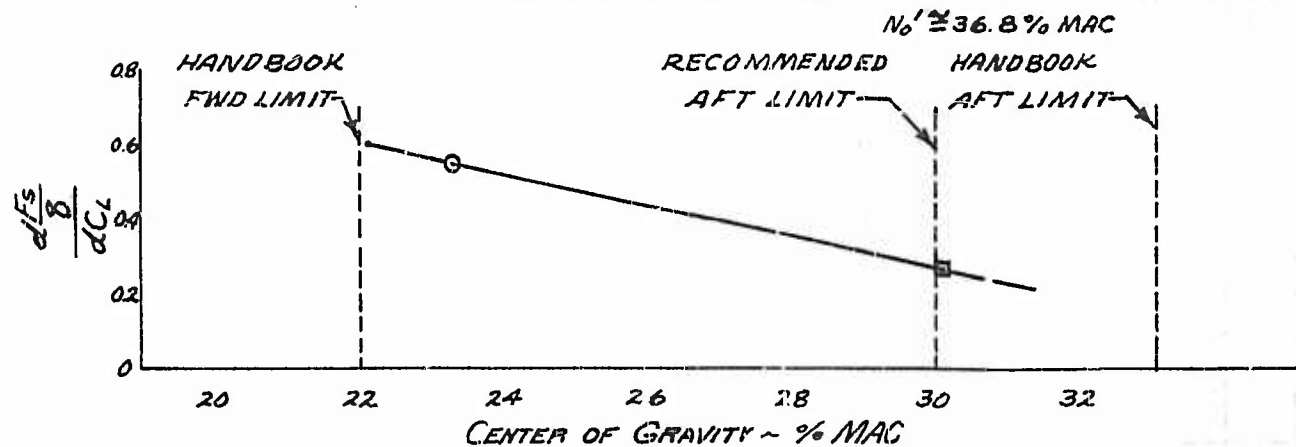
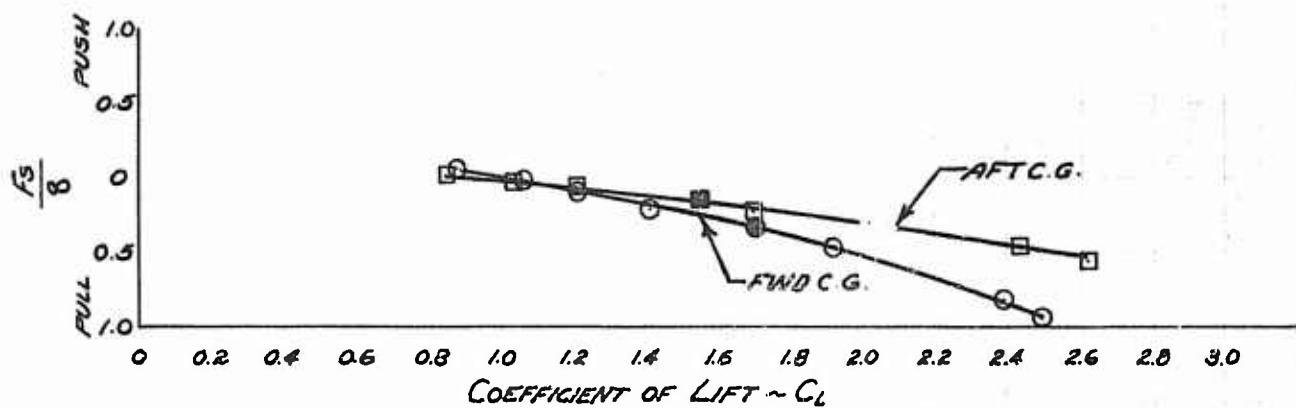
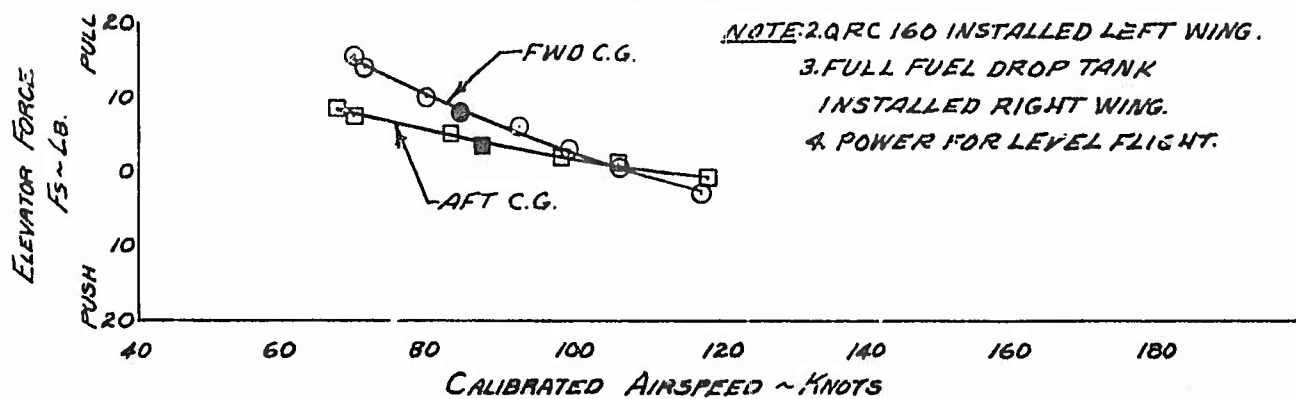


FIGURE NO. 9  
MANEUVERING FLIGHT CHARACTERISTICS  
OV-10A SN 61-2699

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

SYMBOL	C.G. POSITION % MAC	GROSS WT. LB.	AVG. $V_c$ KTS.	ELEVATOR TRIM TAB POSITION-DEG.	ALTITUDE FT.
○	24.1 (FWD C.G.)	13300	94	0.5° NOSE UP	7500
□	29.85 (AFT C.G.)	13550	95	1.5° NOSE UP	7500

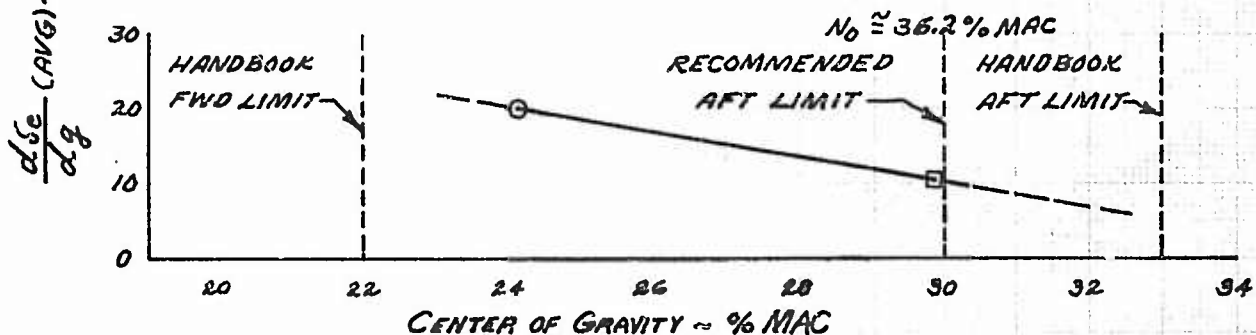
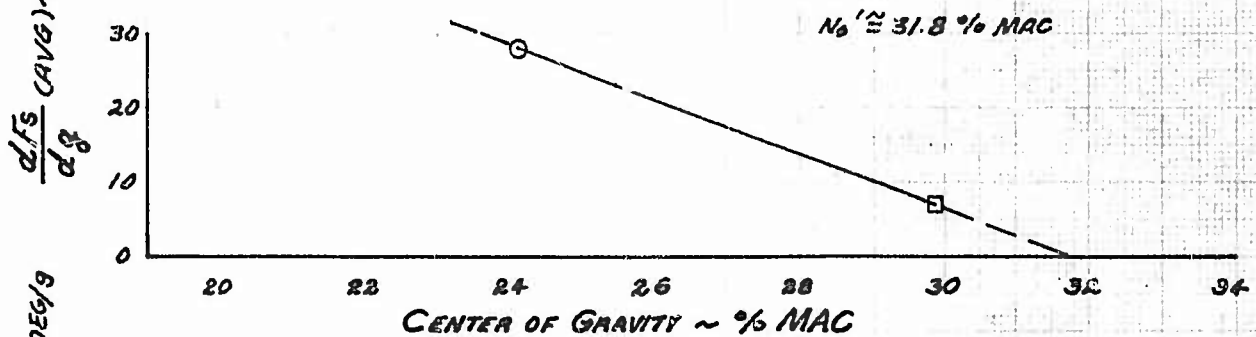
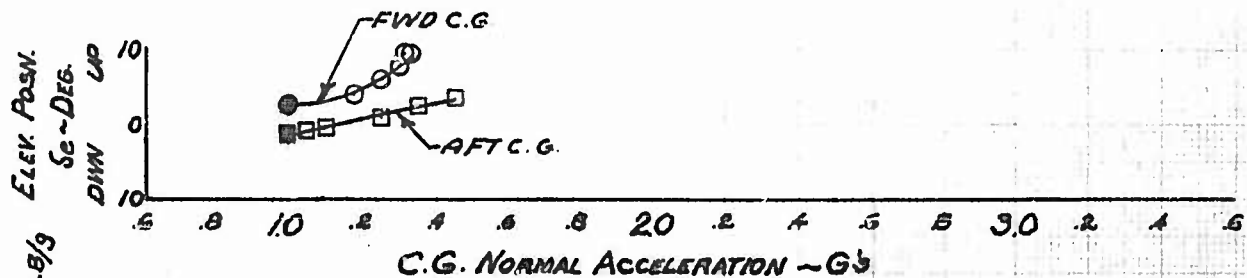
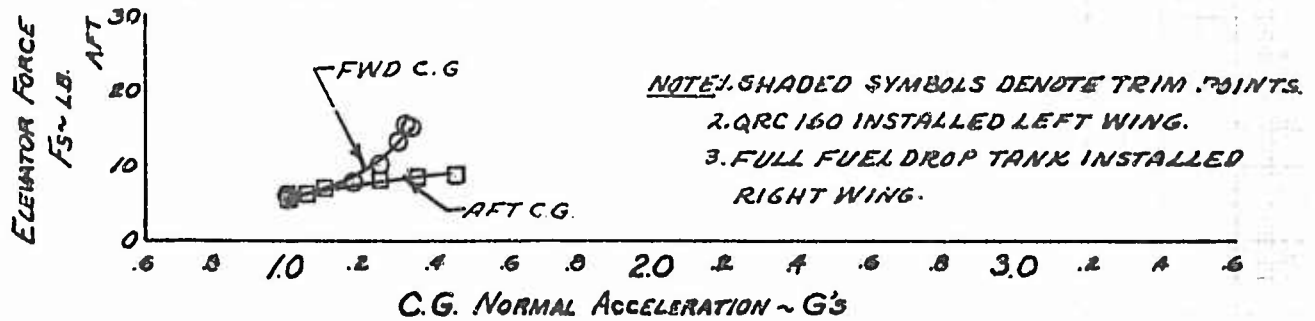


FIGURE No. 10  
MANEUVERING FLIGHT CHARACTERISTICS  
OV-10 5/N 61-2689

CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT

SYMBOL	C.G. POSITION % MAC	GROSS Wt. LB.	AVG. $V_0$ KTS.	ELEVATOR TRIM TAB POSITION ~ DEG.	ALTITUDE FT.
○	23.45 (FWD C.G.)	13750	178	1.5° NOSE DOWN	7500
□	29.80 (AFT C.G.)	13400	177	NOT AVAILABLE	7500

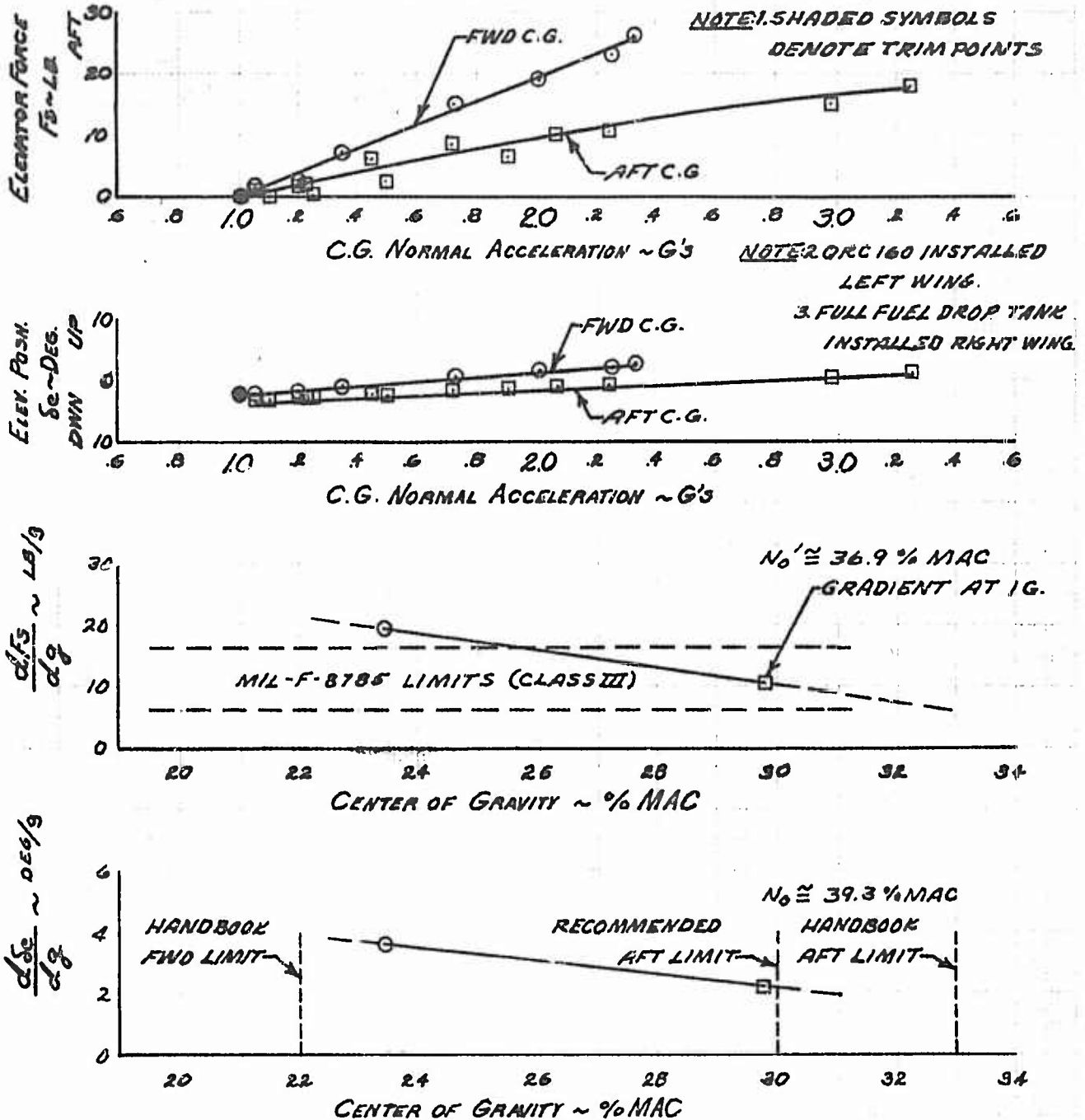
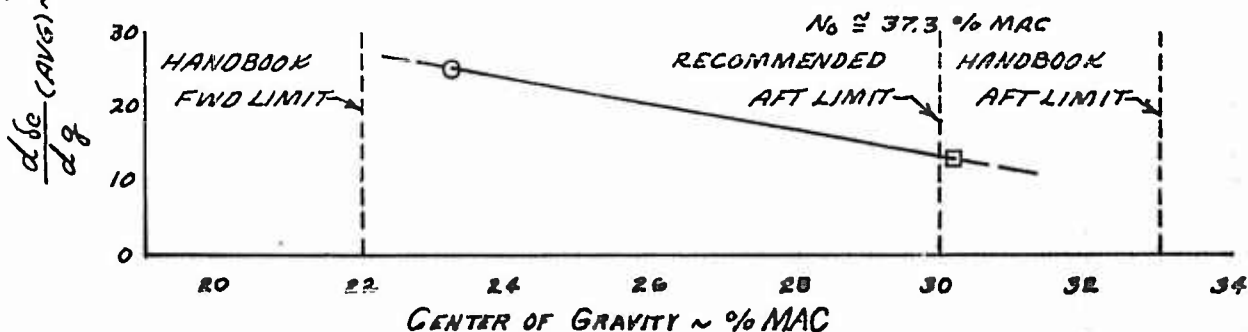
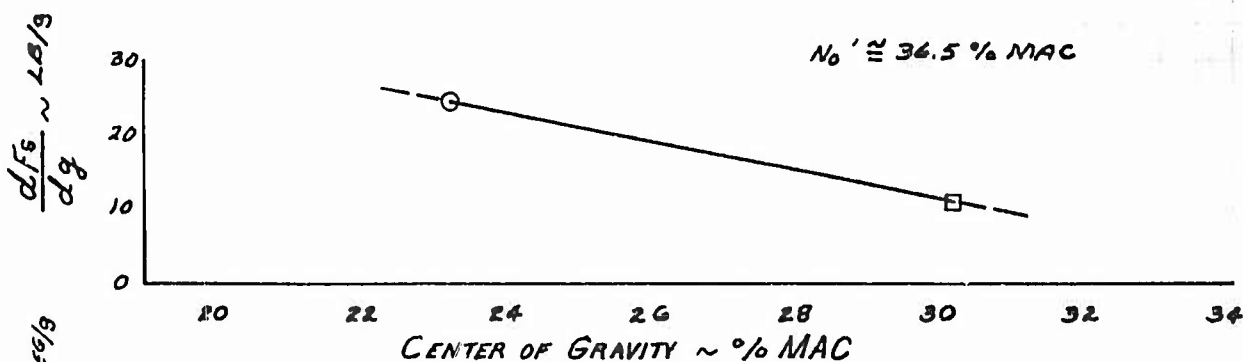
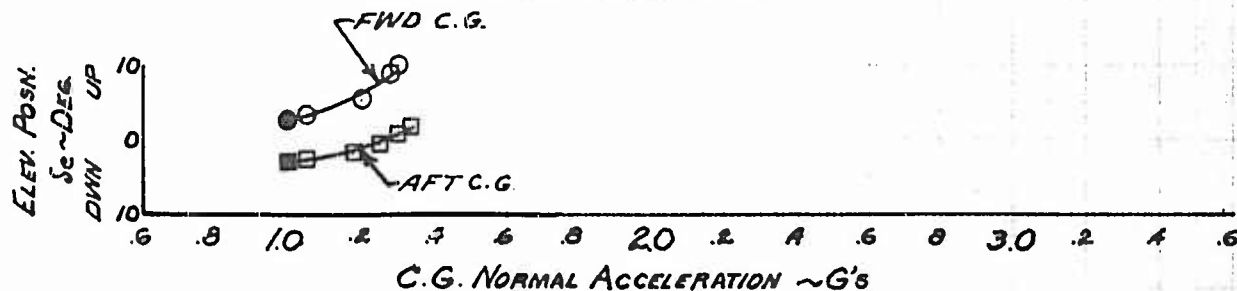
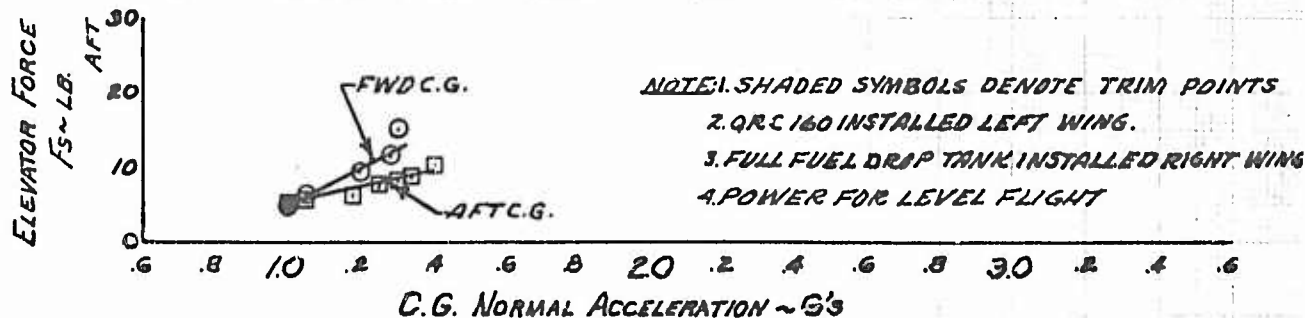


FIGURE No. 11  
MANEUVERING FLIGHT CHARACTERISTICS  
OV-10 SN 61-2699

CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN

SYMBOL	C.G. POSITION % MAC	GROSS WT. LB.	AVG. $V_0$ KTS.	ELEVATOR TRIM TAB POSITION ~ DEG.	ALTITUDE FT.
○	23.2 (FWD C.G.)	13300	87.0	0.7° NOSE UP	7500
□	30.2 (AFT C.G.)	13200	85.5	1.2° NOSE UP	7500



**FIGURE No. 12**  
**STATIC LATERAL - DIRECTIONAL STABILITY**  
**OV-1C 1/4N 61-2699**

**CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN**

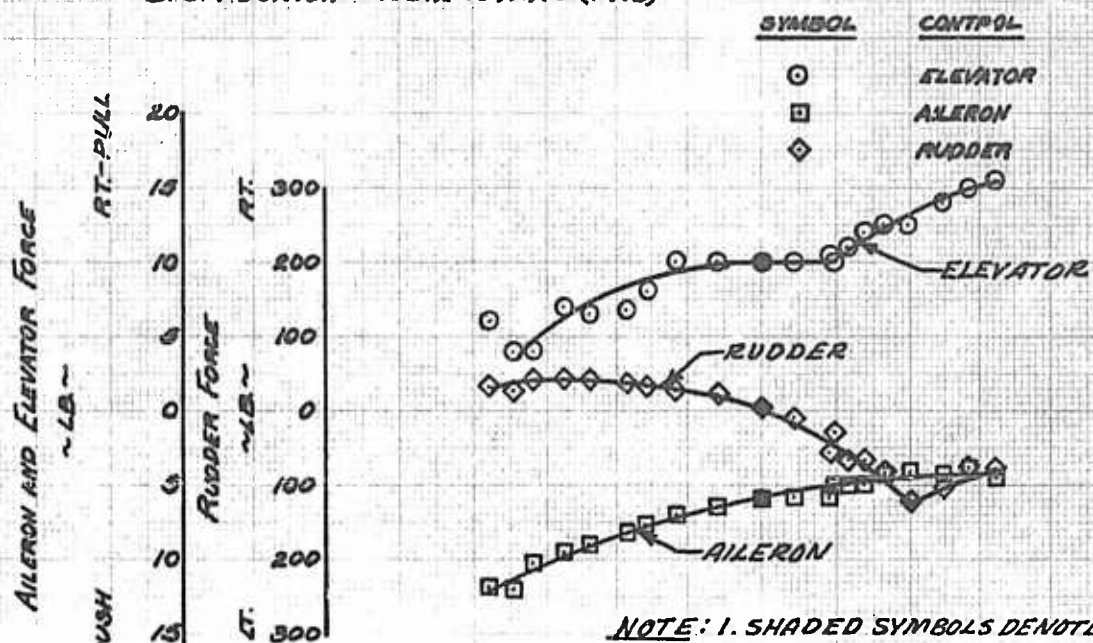
**CAS = 96.5 KTS.**

**ALTITUDE = 8640 FT.**

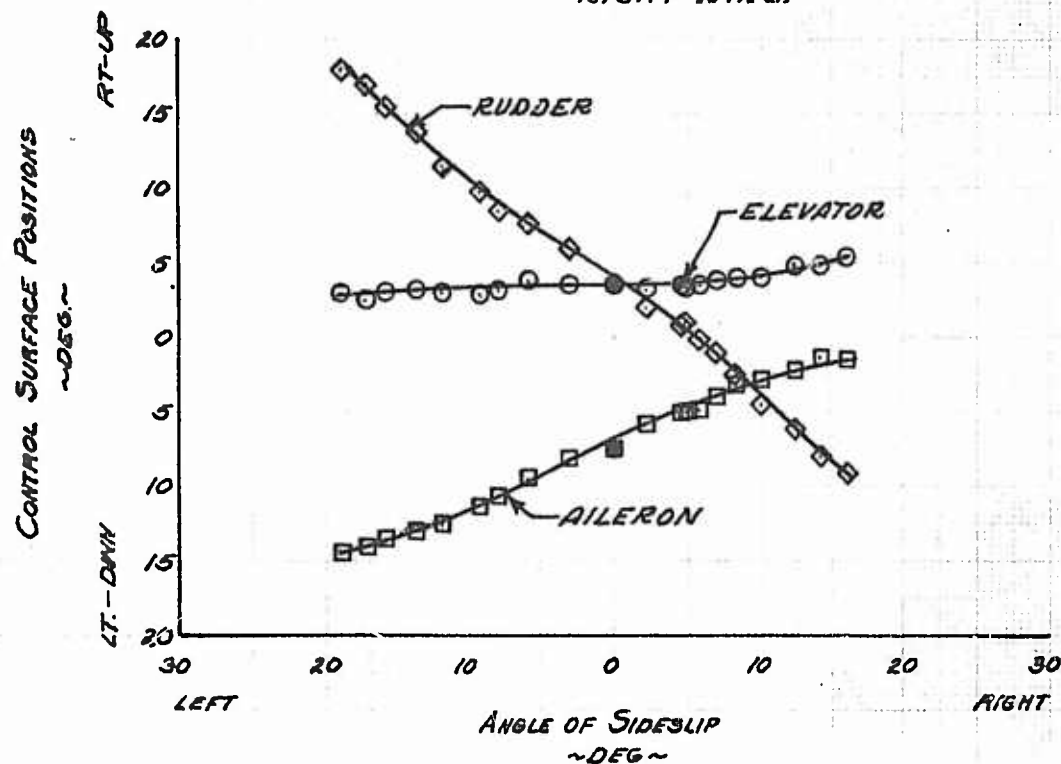
**WEIGHT = 13,540 LB.**

**RUDDER TRIM TAB POSITION = 7.5° NOSE RIGHT**

**C.G. POSITION = 23.2% MAC (FWD)**



**NOTE: 1. SHADED SYMBOLS DENOTE TRIM POINT**  
**2. QRC 160 INSTALLED LEFT WING**  
**3. FULL FUEL DROPTANK INSTALLED RIGHT WING.**



**FIGURE No. 13**  
**STATIC LATERAL - DIRECTIONAL STABILITY**  
**OV-10 3/4N 61-2699**

**CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN**

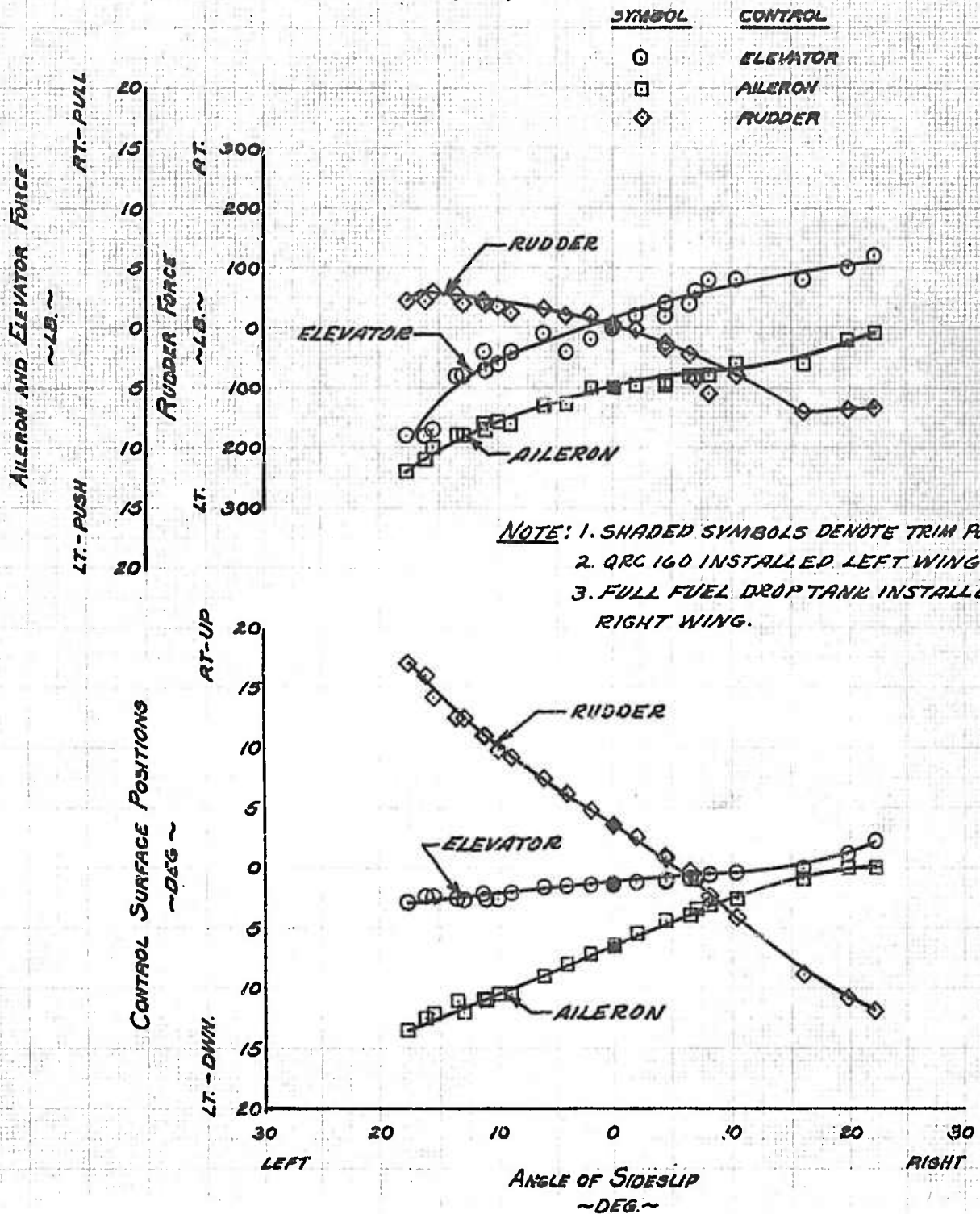
**CAS = 99.7 KTS.**

**ALTITUDE = 5850 FT.**

**WEIGHT = 13,460 LBS.**

**RUDDER TRIM TAB POSITION = NOT AVAILABLE**

**C.G. POSITION = 29.8 % MAC (AFT)**

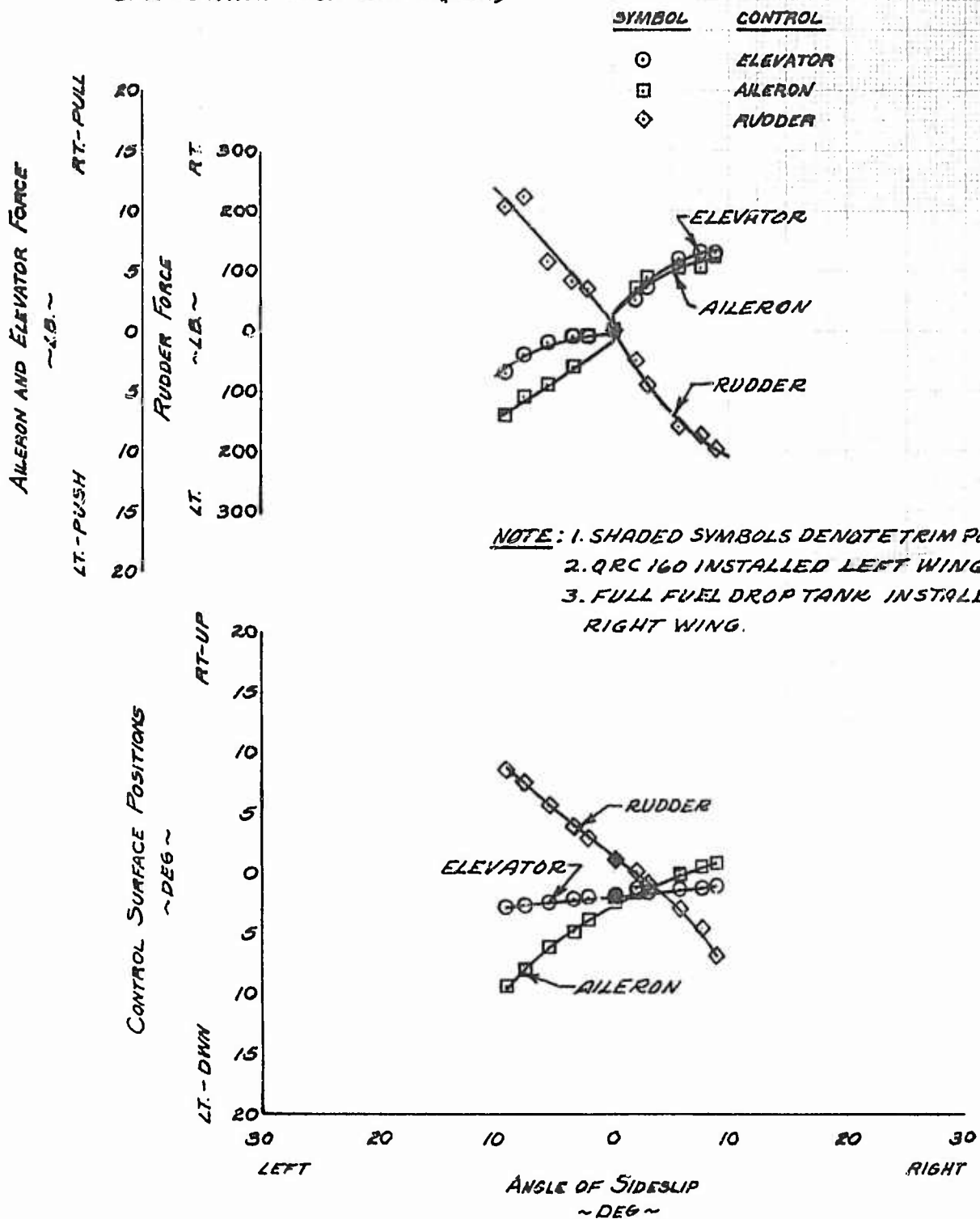


**FIGURE No. 14**  
**STATIC LATERAL - DIRECTIONAL STABILITY**  
**OV-10C #N 61-2699**

**CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT**

**CAS = 177.0 KTS**  
**WEIGHT = 13920 LBS.**  
**RUDDER TRIM TAB POSITION = 0°**  
**C.G. POSITION = 23.3% MAC (FWD)**

**ALTITUDE = 8600 FT.**



**FIGURE No. 15**  
**STATIC LATERAL - DIRECTIONAL STABILITY**  
**OV-10 5/16 61-2699**

**CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT**

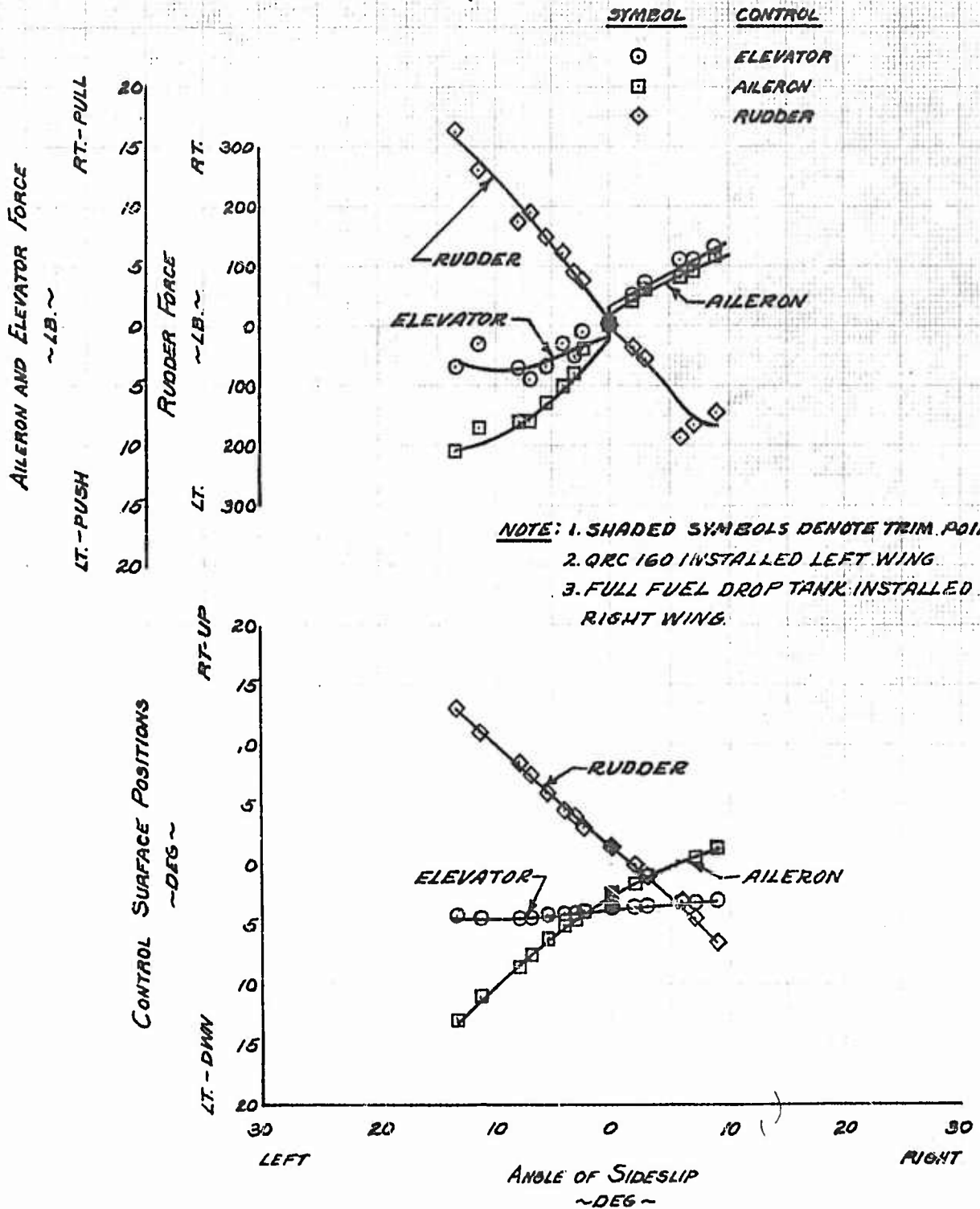
**CAS = 180.5 KTS.**

**ALTITUDE = 8390 FT.**

**WEIGHT = 13,220 LB.**

**RUDDER TRIM TAB POSITION = NOT AVAILABLE**

**C.G. POSITION = 29.8 % MAC (AFT)**



**FIGURE No. 16**  
**STATIC LATERAL-DIRECTIONAL STABILITY**  
**OV-10 3/4 61-2699**

**CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN**

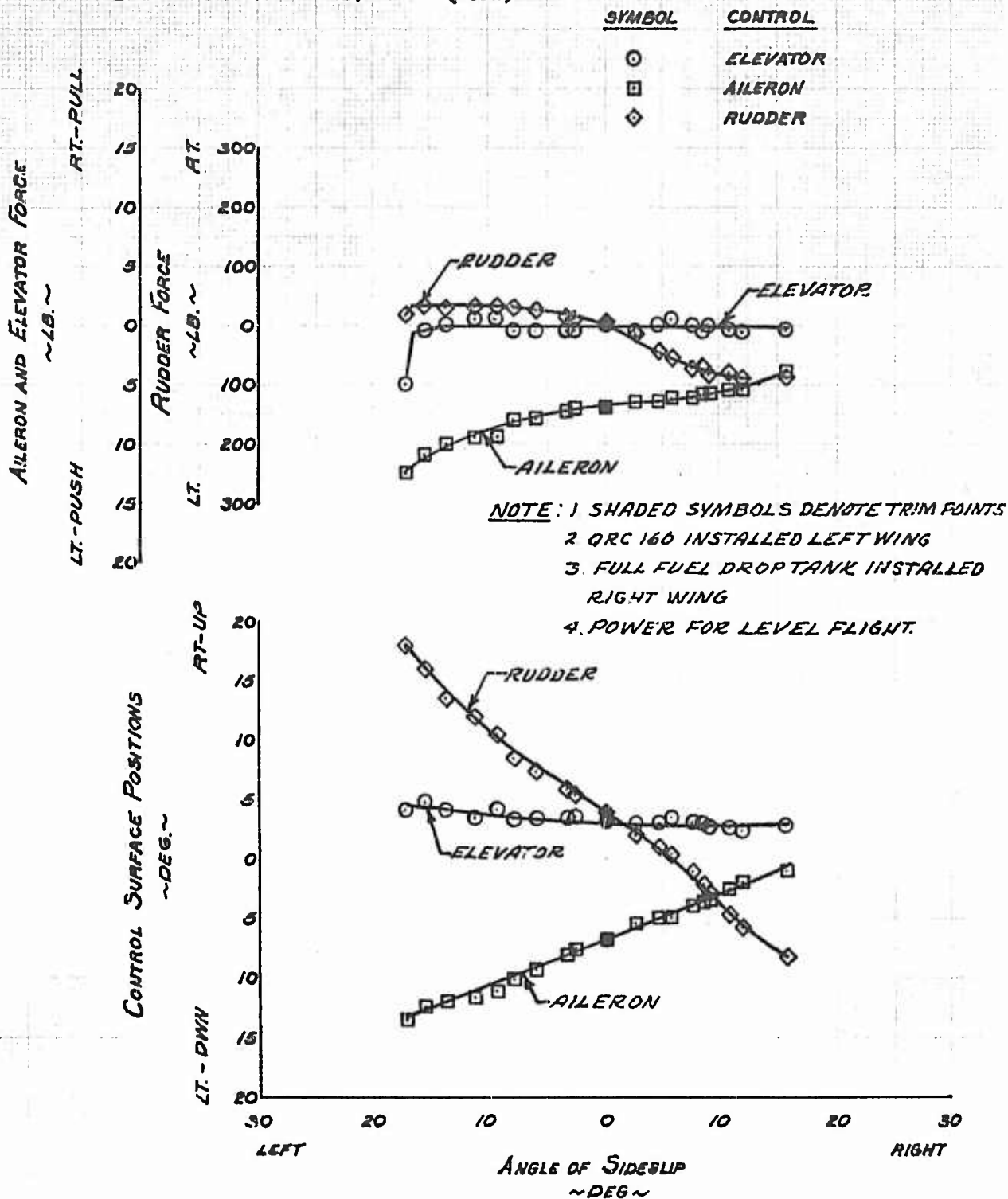
**CAS = 87.2 KTS.**

**ALTITUDE = 7805 FT.**

**WEIGHT = 13,350 LB.**

**RUDDER TRIM TAB POSITION = 10° NOSE RT.**

**C.G. POSITION = 23.2% MAC (FWD)**



**FIGURE No. 17**  
**STATIC LATERAL - DIRECTIONAL STABILITY**  
**OV-10 5/11 61-2699**

**CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN**

**CAS = 87.2 KTS.**

**ALTITUDE = 6150 FT.**

**WEIGHT = 12970 LB.**

**RUDDER TRIM TAB POSITION = NOT AVAILABLE**

**C.G. POSITION = 30.1 % MAC (AFT)**

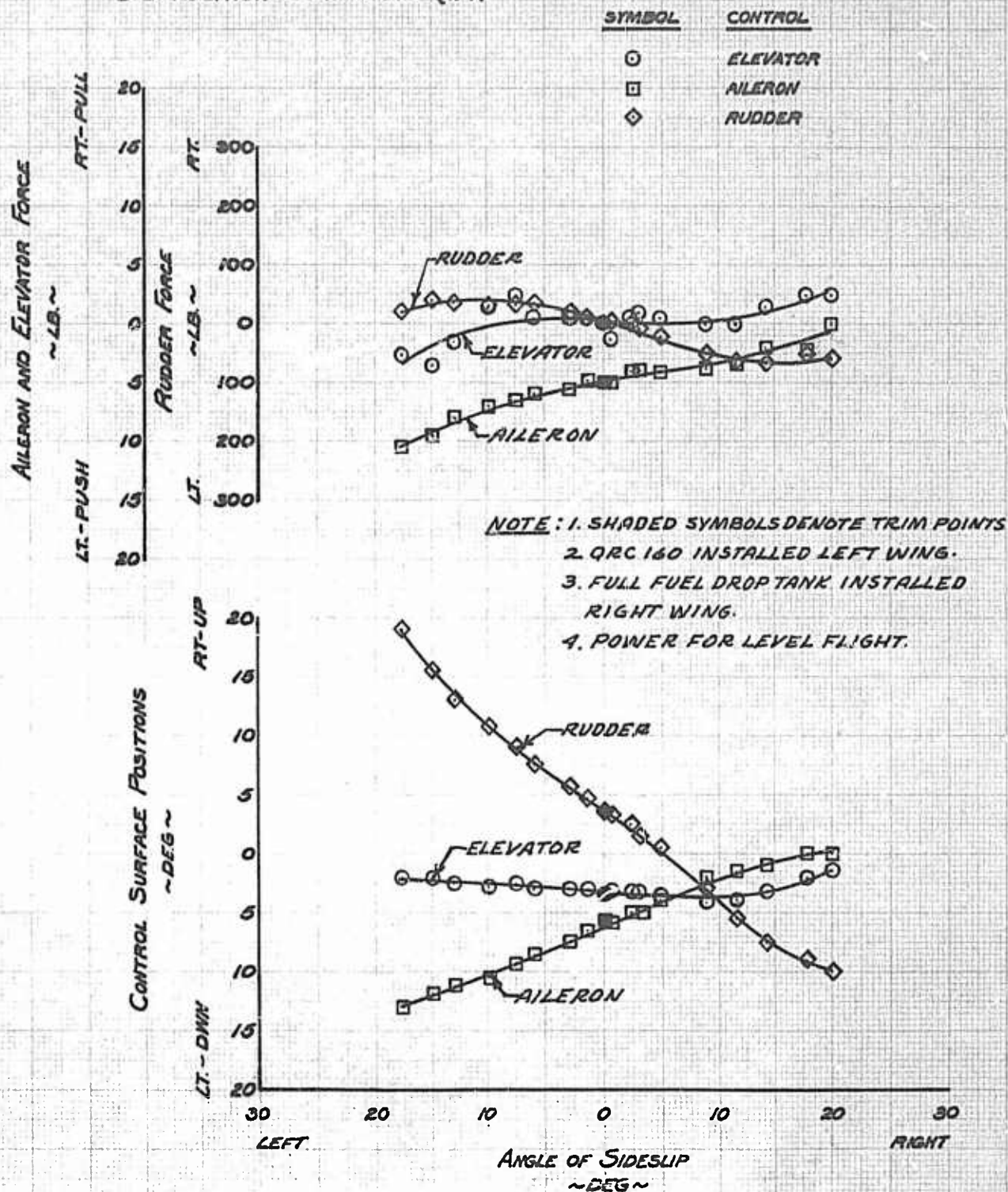


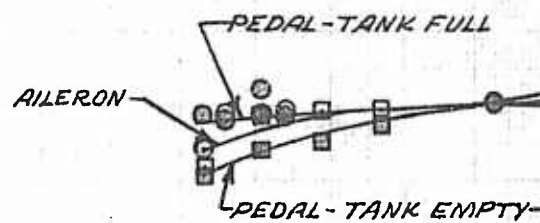
FIGURE NO. 18  
COORDINATED AILERON ROLLS  
OV-1C 7N 61-2699

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

SYMBOL	CAS - KTS	ALTITUDE - FT	GROSS WEIGHT - LB	DROP TANK
○	94.5	8820	13000	FULL
□	95.5	8600	12200	EMPTY

MAX RUDDER & AILERON  
FORCE - LB

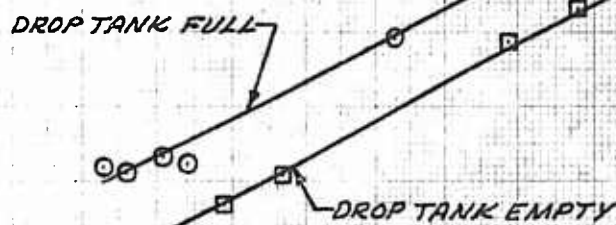
RIGHT  
LEFT



NOTE: 1. SHADED SYMBOLS DENOTE  
PEDAL FORCES.  
2. GRC 160 INSTALLED LEFT WING.  
3. DROP TANK 1 INSTALLED RIGHT WING.

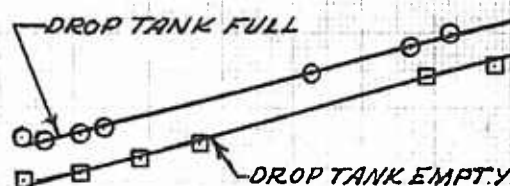
HELIX ANGLE  
PE  
2V

RIGHT  
LEFT



ROLL RATE  
DEG/SEC

RIGHT  
LEFT



Up (LEFT ROLL) LEFT AILERON DEFLECTION ~ DEG. ~ DOWN (RIGHT ROLL)

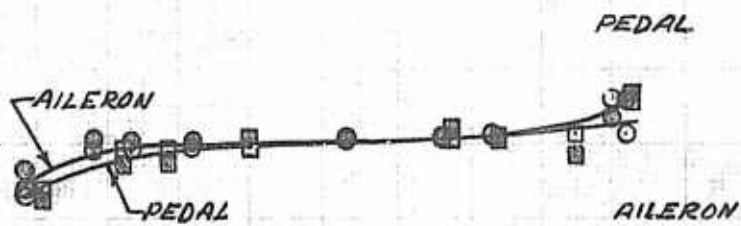
FIGURE No 19  
COORDINATED AILERON ROLLS  
OV-10 61-2699

CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT

SYMBOL	CAS ~ KTS	ALTITUDE ~ FT	GROSS WEIGHT ~ LB	DROP TANK
○	178.0	8440	13500	FULL
□	177.0	8850	12700	EMPTY

MAX RUDDER & AILERON  
FORCE ~ LB

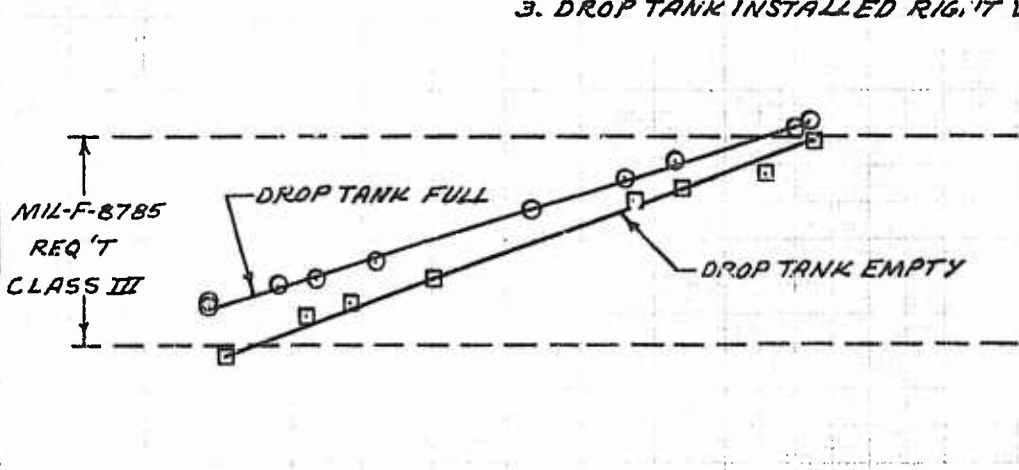
RIGHT  
LEFT



NOTE: 1. SHADED SYMBOLS DENOTE PEDAL FORCES.  
2. QRC 16" INSTALLED LEFT WING  
3. DROP TANK INSTALLED RIGHT WING

HELIX ANGLE  
DEG/2V

RIGHT  
LEFT



ROLL RATE  
DEG/SEC

RIGHT  
LEFT

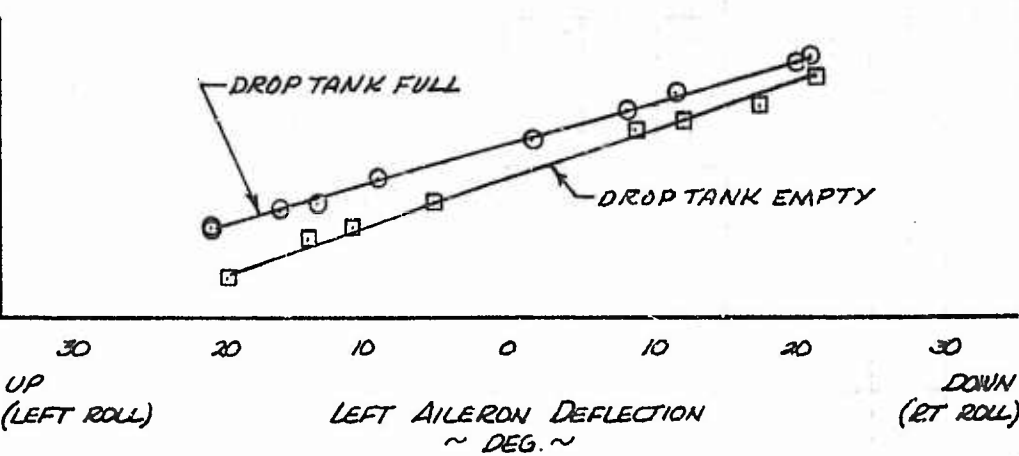
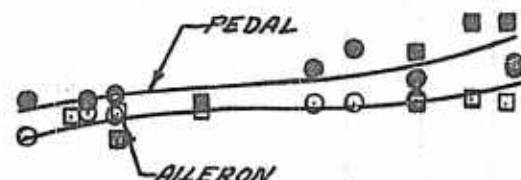


FIGURE No. 20  
COORDINATED AILERON ROLLS  
OV-1C <sup>5</sup>/<sub>16</sub> 61-2699

CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN

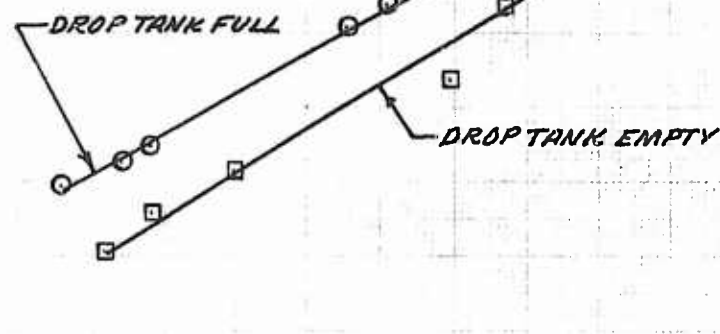
SYMBOL	CAS ~ KTS	ALTITUDE ~ FT	GROSS WEIGHT ~ LB	DROPTANK
○	87.0	8710	13300	FULL
□	87.0	9160	12000	EMPTY

Max Rudder & Aileron  
Force - LB.  
RIGHT  
LEFT



NOTE: 1. SHADED SYMBOLS DENOTE  
PEDAL FORCES.  
2. QRC 160 INSTALLED LEFT WING  
3. DROP TANK INSTALLED RIGHT WING  
4. POWER FOR LEVEL FLIGHT

HELIX ANGLE  
 $\frac{P_b}{2V}$   
RIGHT  
LEFT



ROLL RATE  
deg/sec  
RIGHT  
LEFT

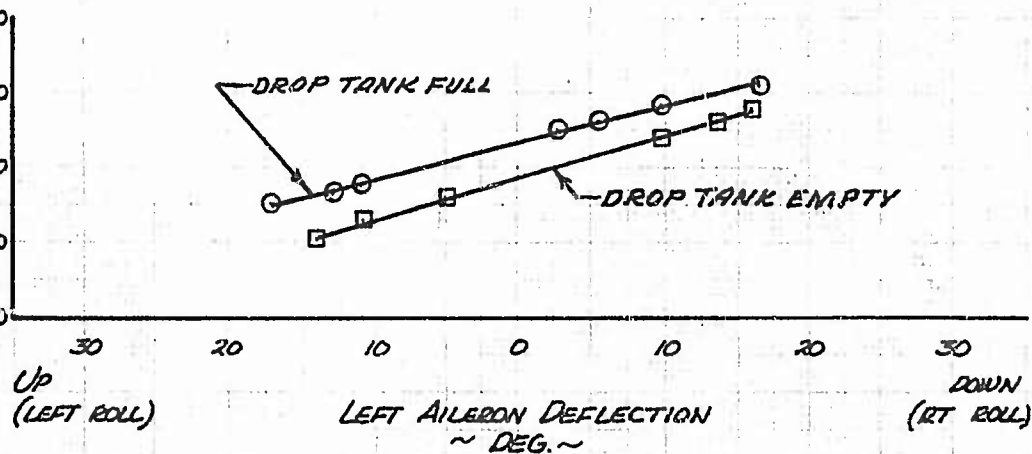


FIGURE No. 21  
PEDAL FIXED AILERON ROLLS  
OV-1C S/N 61-2699

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

SYMBOL	CAS-KTS.	ALTITUDE~FT.	GROSS WT.~LB.	DROPTANK
○	99.7	7700	12800	FULL
□	99.7	8040	12800	EMPTY

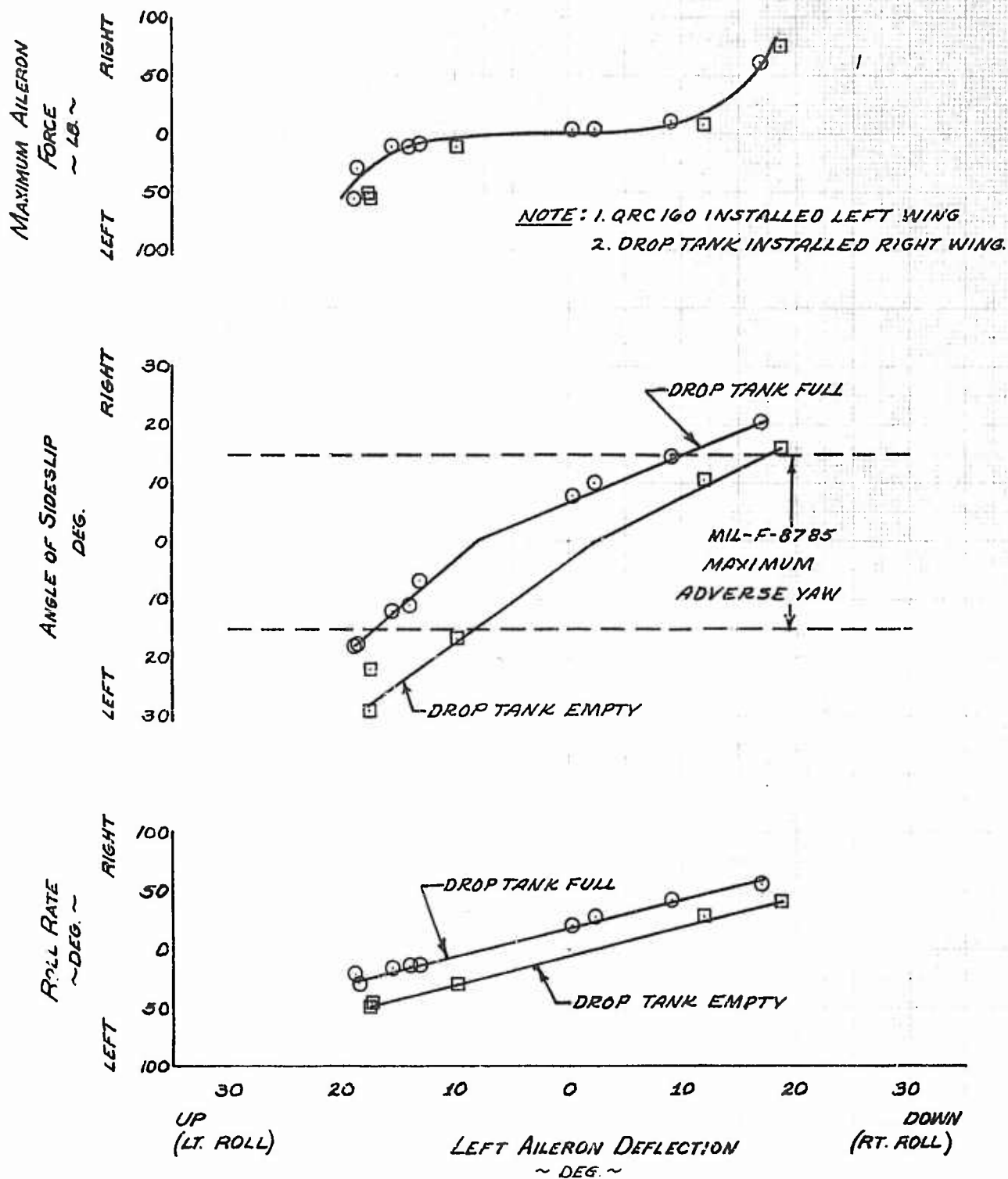


FIGURE No. 2.2  
 PEDAL FIXED AILERON ROLLS  
 OV-10 5/11 61-2699

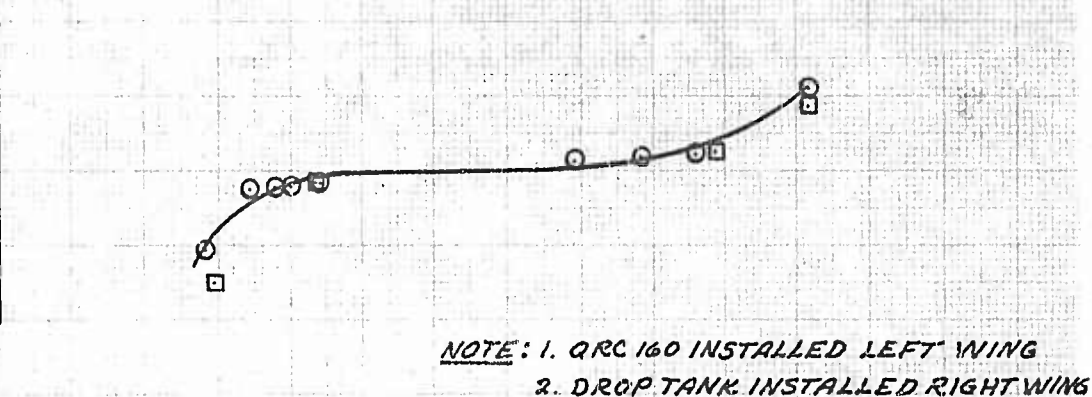
CONFIGURATION: CRUISE - POWER FOR LEVEL FLIGHT

SYMBOL	CAS-KTS.	ALTITUDE ~ FT.	GROSS WT. ~ LB.	DROP TANK
○	177.2	8420	13350	FULL
□	177.2	8780	13500	EMPTY

MAXIMUM AILERON  
 FORCE  
 ~ LB. ~

RIGHT  
 LEFT

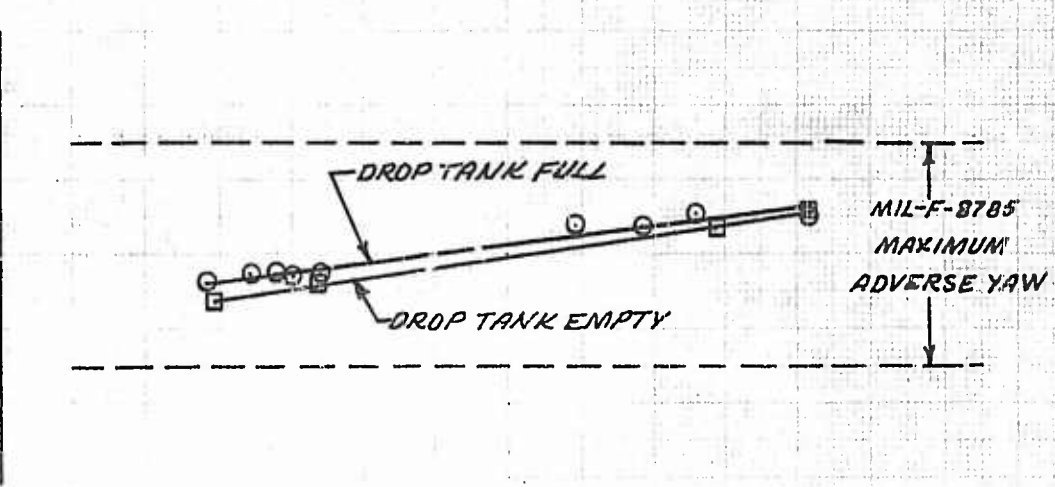
100  
 50  
 0  
 50  
 100



ANGLE OF SIDESLIP  
 DEG.

RIGHT  
 LEFT

30  
 20  
 10  
 0  
 10  
 20  
 30



ROLL RATE  
 ~ DEG. ~

RIGHT  
 LEFT

100  
 50  
 0  
 50  
 100

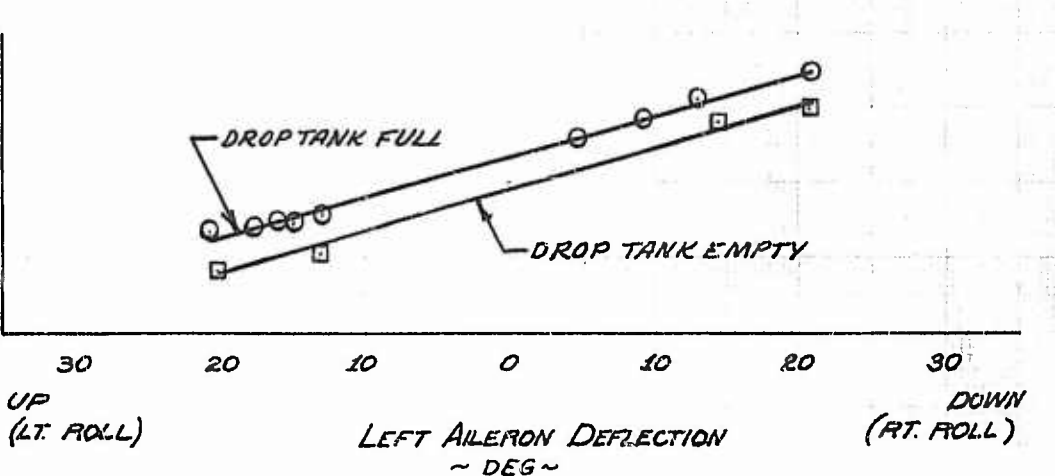


FIGURE No. 23  
PEDAL FIXED AILERON ROLLS  
OV-1C S/N 61-2699

CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN

SYMBOL	CAS-KTS.	ALTITUDE ~ FT.	GROSS WT. ~ LB.	DROP TANK
○	87.3	7100	13250	FULL
□	87.3	9160	12850	EMPTY

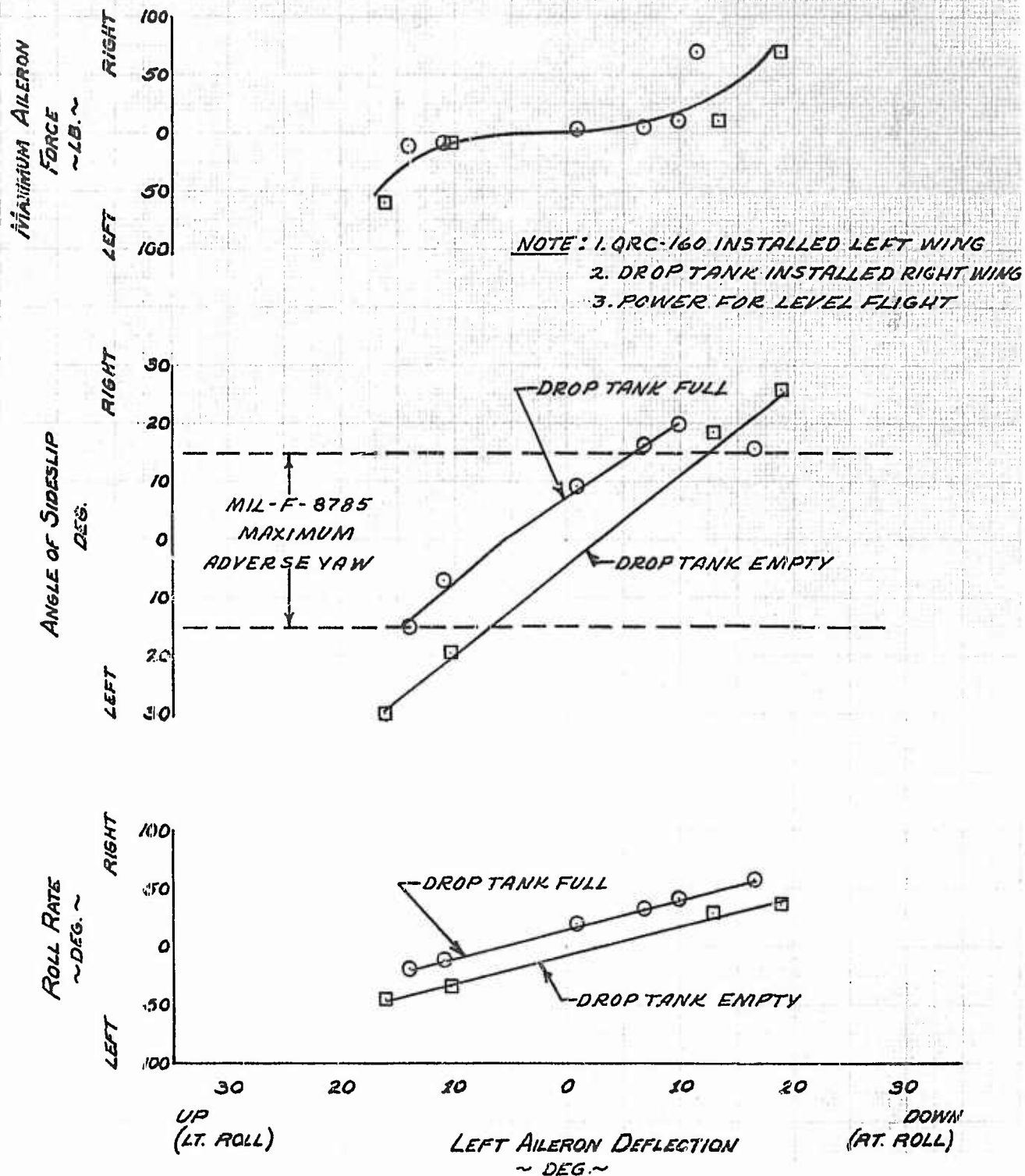


FIGURE No. 24  
COORDINATED AILERON ROLLS  
OV-1C S/N 61-2699

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

WEIGHT: 13000 LB  
CAS: 94.5 KNOTS

ALTITUDE: 9000 FT.

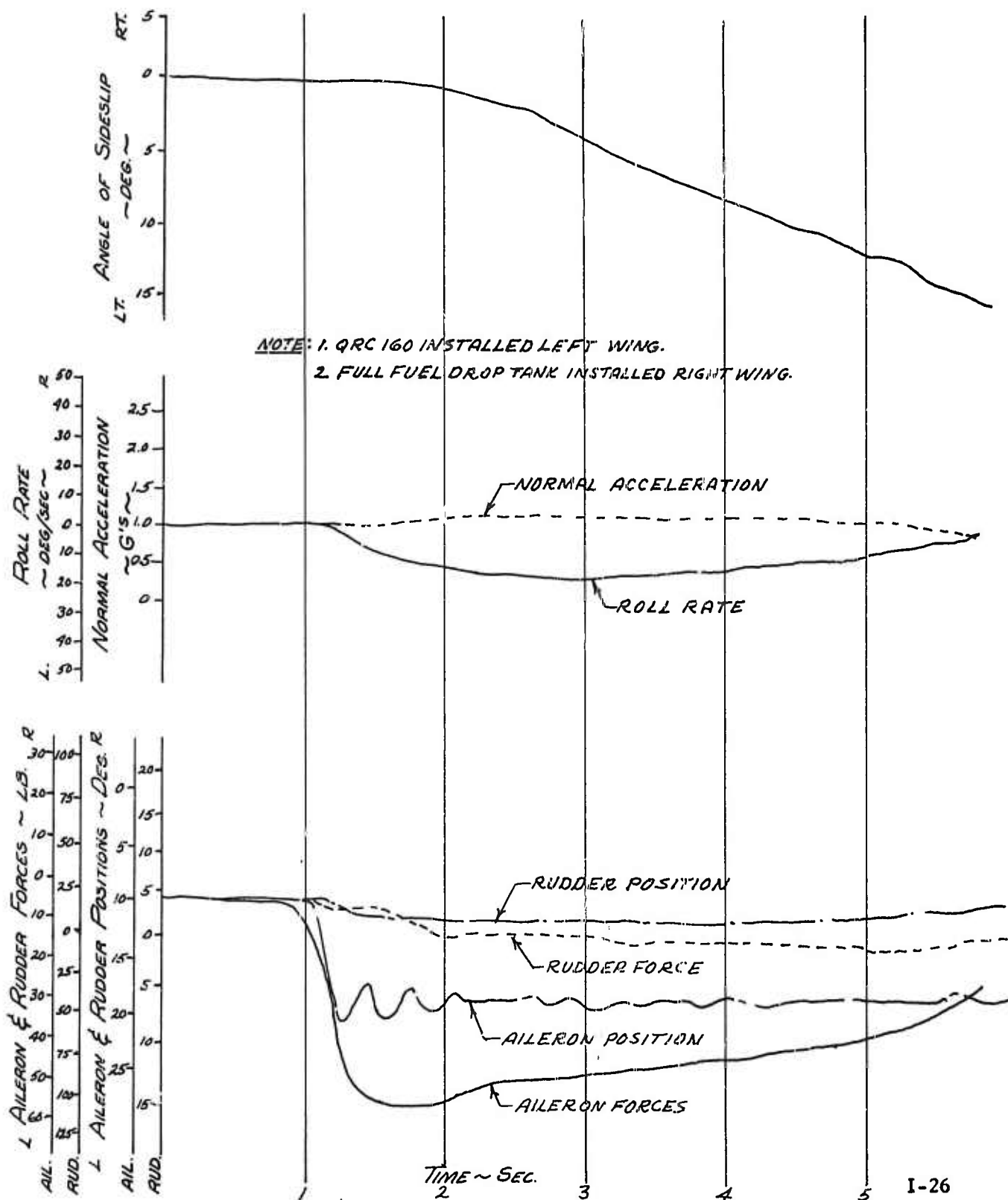


FIGURE No. 25  
 PEDAL FIXED AILERON ROLLS  
 OV-1C S/N 61-2699

CONFIGURATION: TAKE-OFF "15° FLAP GEAR DOWN

WEIGHT: 12700 LB

ALTITUDE: 8000 FT.

CAS: 94.5 KNOTS

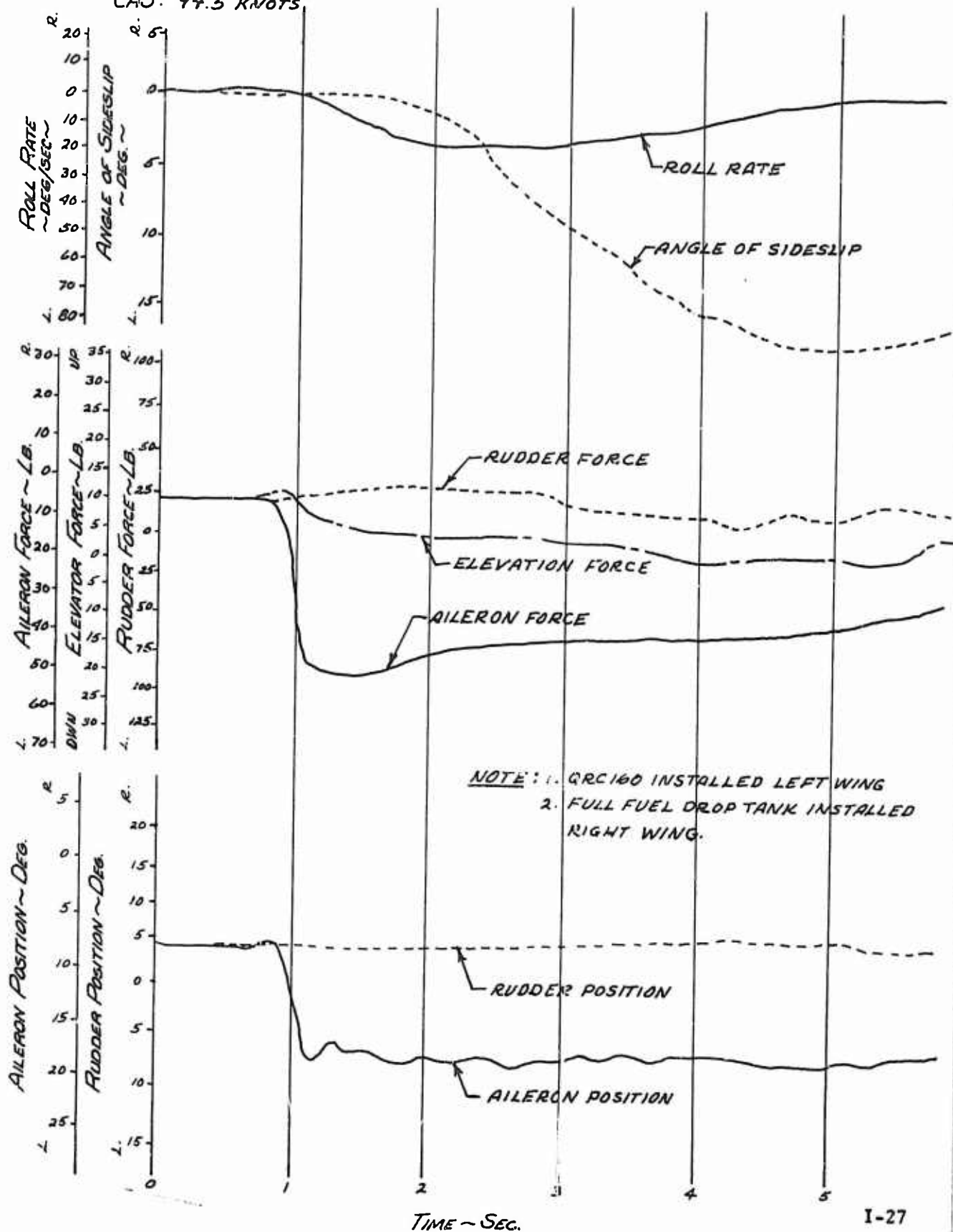


FIGURE No. 26  
COORDINATED AILERON ROLLS  
OV-1C 61-2699

CONFIGURATION: CLEAN

WEIGHT: 13500 LB.  
CAS: 178 KNOTS

ALTITUDE: 8500 FT.

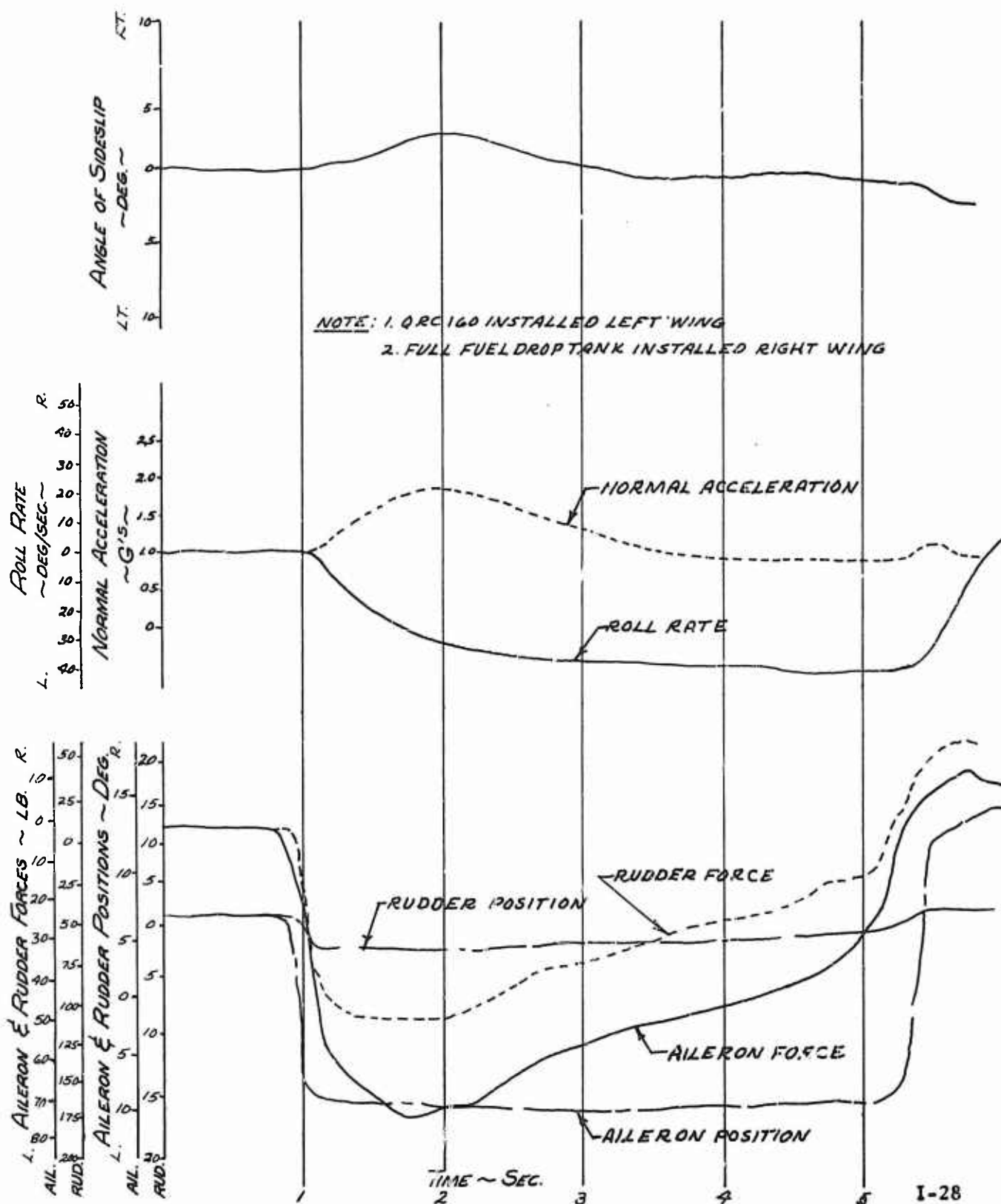


FIGURE 1V. 21  
 PEDAL FIXED AILERON ROLLS

CONFIGURATION: CLEAN

OV-10 5/N 61-2699

WEIGHT: 13200 LB

ALTITUDE: 8500 FT.

CAS: 177 KNOTS

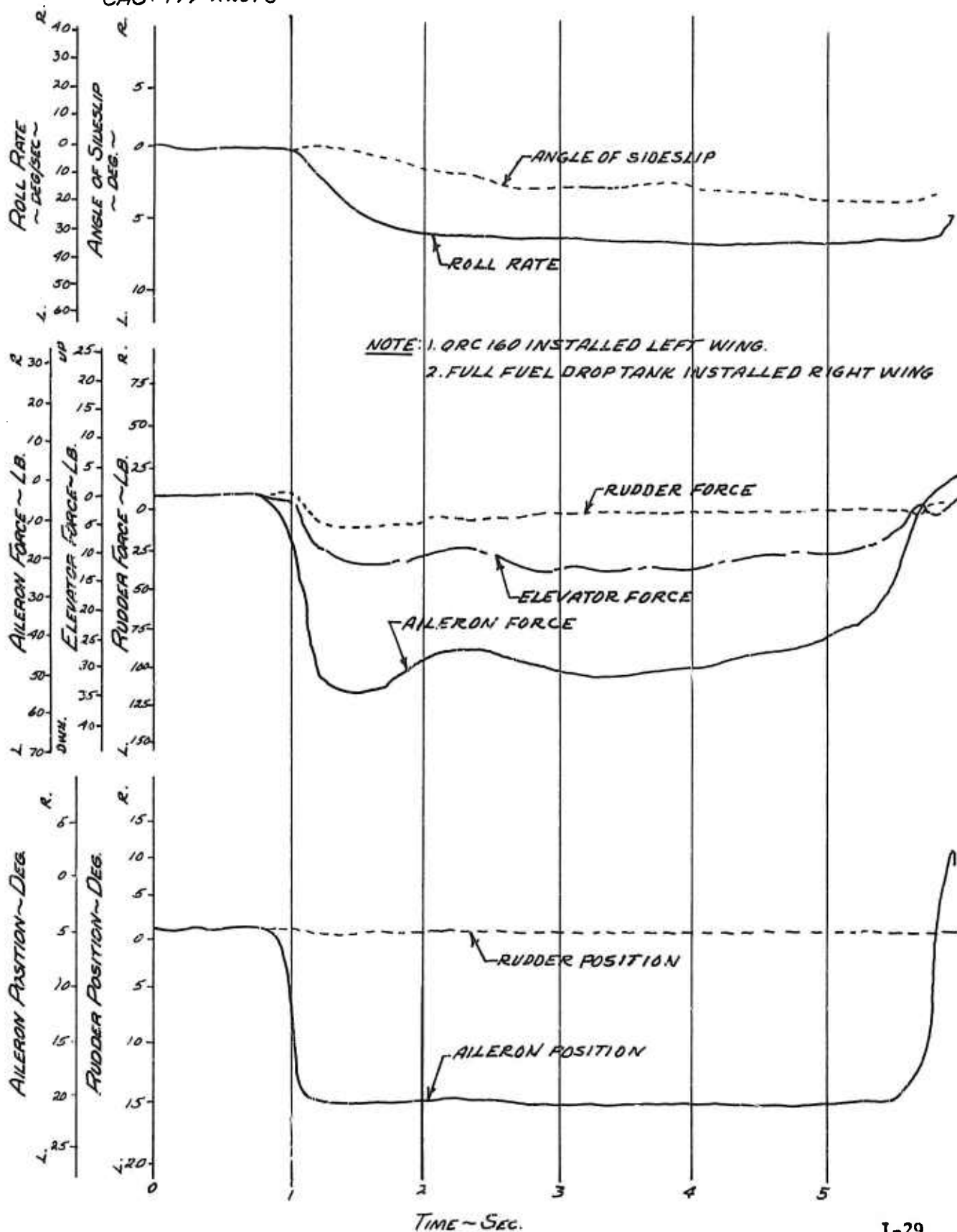


FIGURE No. 28  
STALL SUMMARY  
OV-1C S/N 61-2699

SYM	STALL CAS ~KTS	GROSS WT ~LB	$C_L$ MAX	POWER	CONFIGURATION
○	90.5	14078	1.54	PLF	CLEAN
□	75	13950	2.22	PLF	TAKE-OFF
◇	71	13900	2.47	PLF	POWER APPROACH
▽	87	13379	1.58	PLF	CLEAN
▼	76	13325	2.07	PLF	TAKE-OFF
△	69	13300	2.50	PLF	POWER APPROACH

NOTE

ALL STALLS ARE AT 1 HT/SEC  
AIRSPEED BLEED-OFF RATE.  
CURVES DERIVED FROM AN AVG.  
 $C_L$  MAX FOR SEVERAL ACCELERATED  
AND UNACCELERATED STALLS

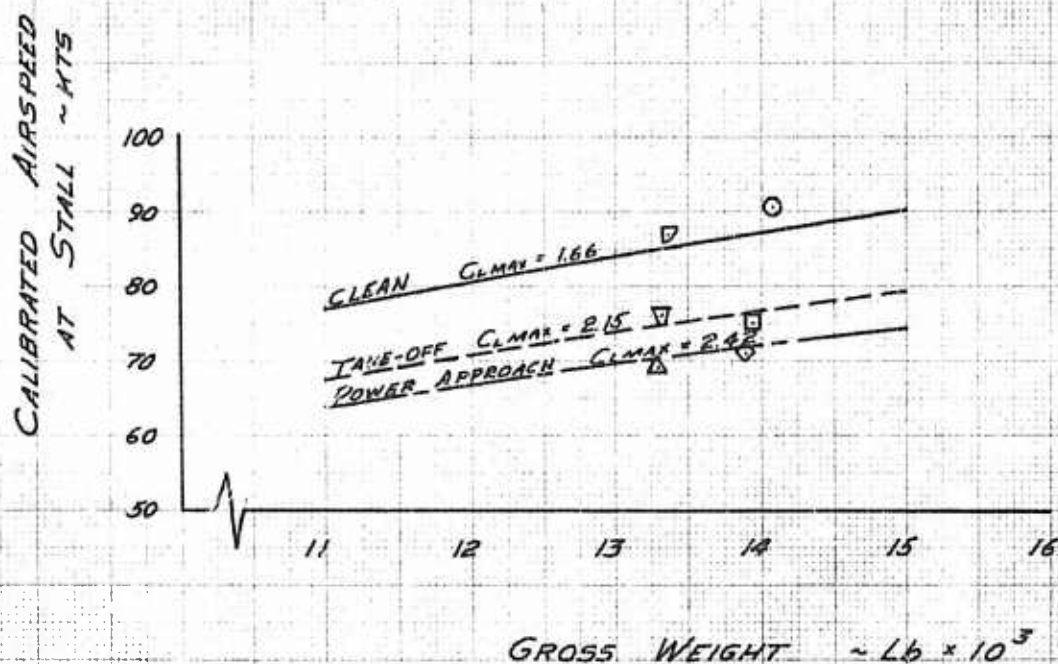


FIGURE No.29  
UNACCELERATED  
STALL TIME HISTORY  
OV-1C #61-2699

CONFIGURATION: TAKE-OFF 15° FLAPS GEAR DOWN

WEIGHT: 13900 LB.

ALTITUDE: 8000 FT.

CAS @ STALL: 77 KNOTS

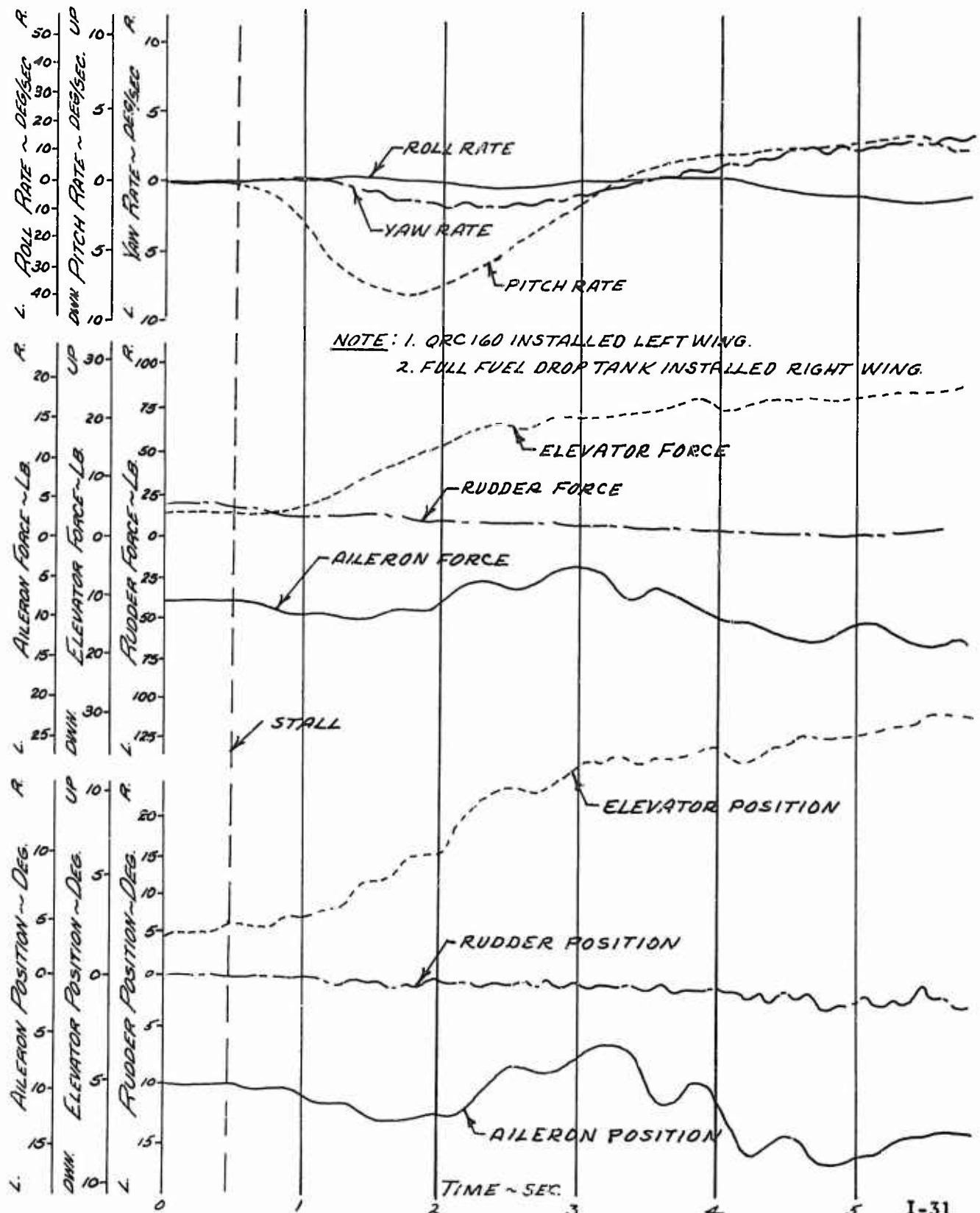


FIGURE NO. 30  
UNACCELERATED  
STALL TIME HISTORY

CONFIGURATION: CLEAN OV-10 SN 61-2699

WEIGHT: 14000 LB

ALTITUDE: 8000 FT.

CAS @ STALL 89 KNOTS

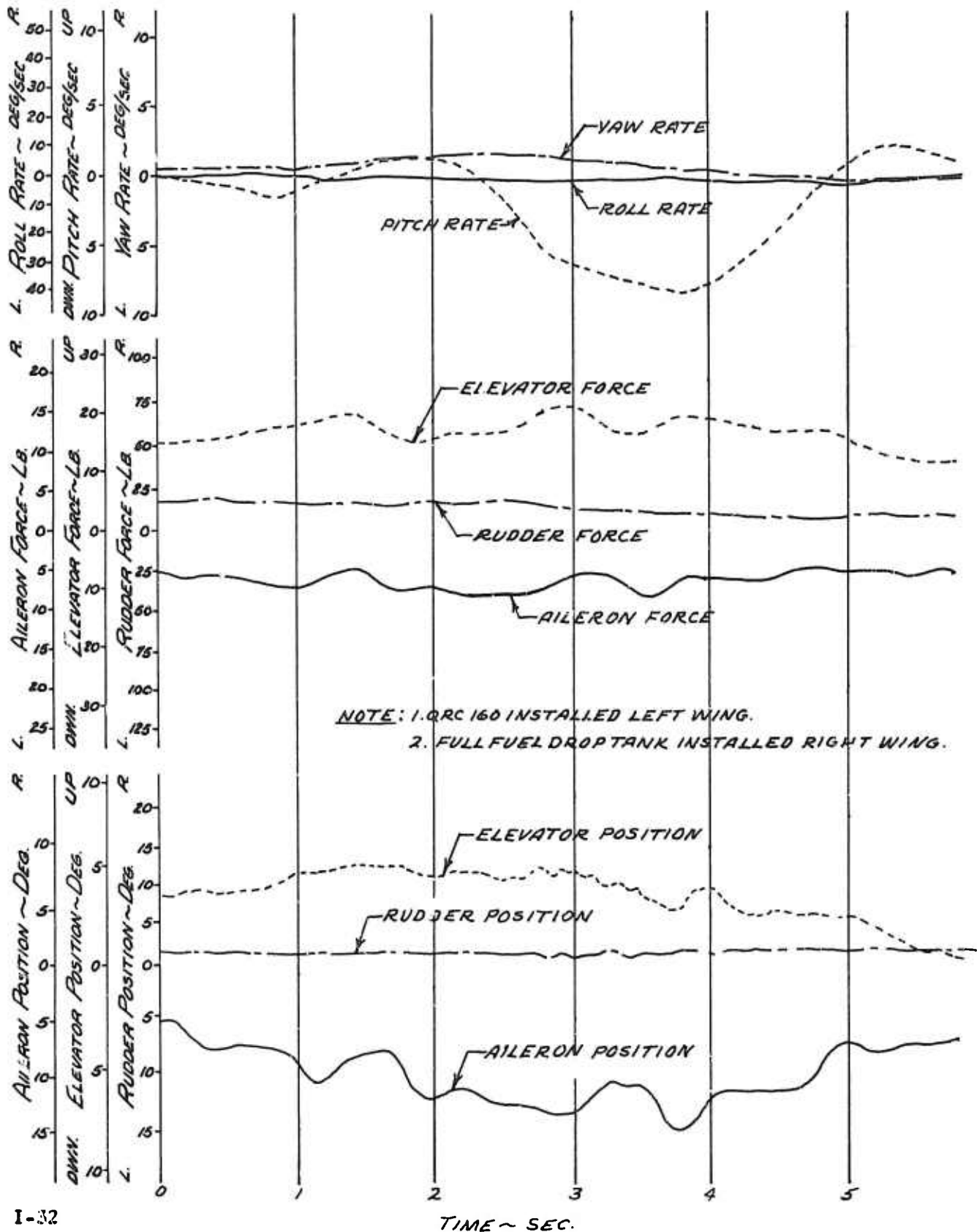


FIGURE No.31  
UNACCELERATED  
STALL TIME HISTORY

OV-10 5/16 61-2699

CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN

WEIGHT: 13900 LB

ALTITUDE: 8000 FT.

CAS @ STALL: 69 KNOTS

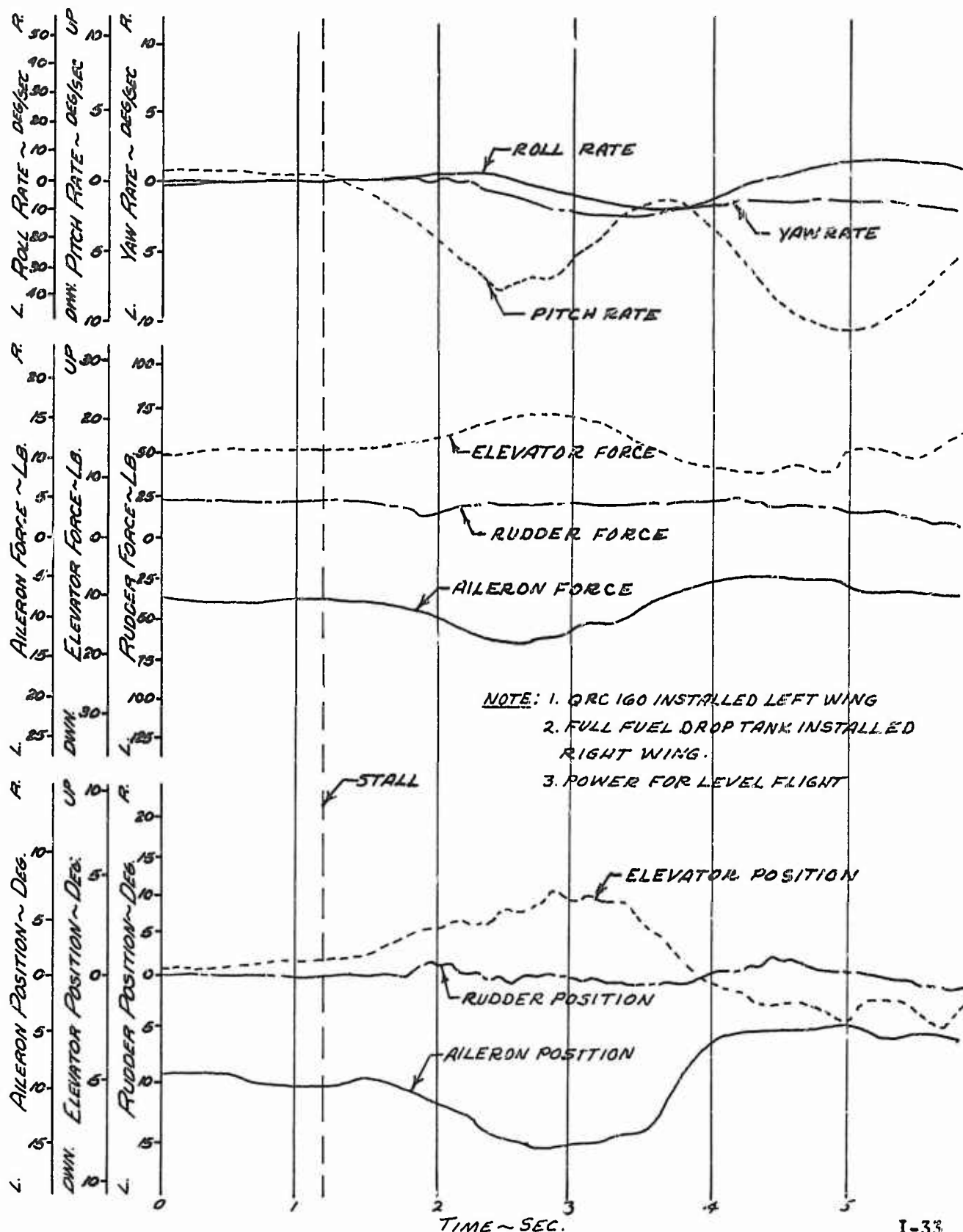


FIGURE No.32  
ACCELERATED  
STALL TIME HISTORY

OV-1C SN 61-2699

CONFIGURATION: POWER APPROACH 45° FLAPS GEAR DOWN

WEIGHT: 13800 LB.

ALTITUDE: 8000 FT

CAS @ STALL: 94.5 KNOTS AT 1.69's

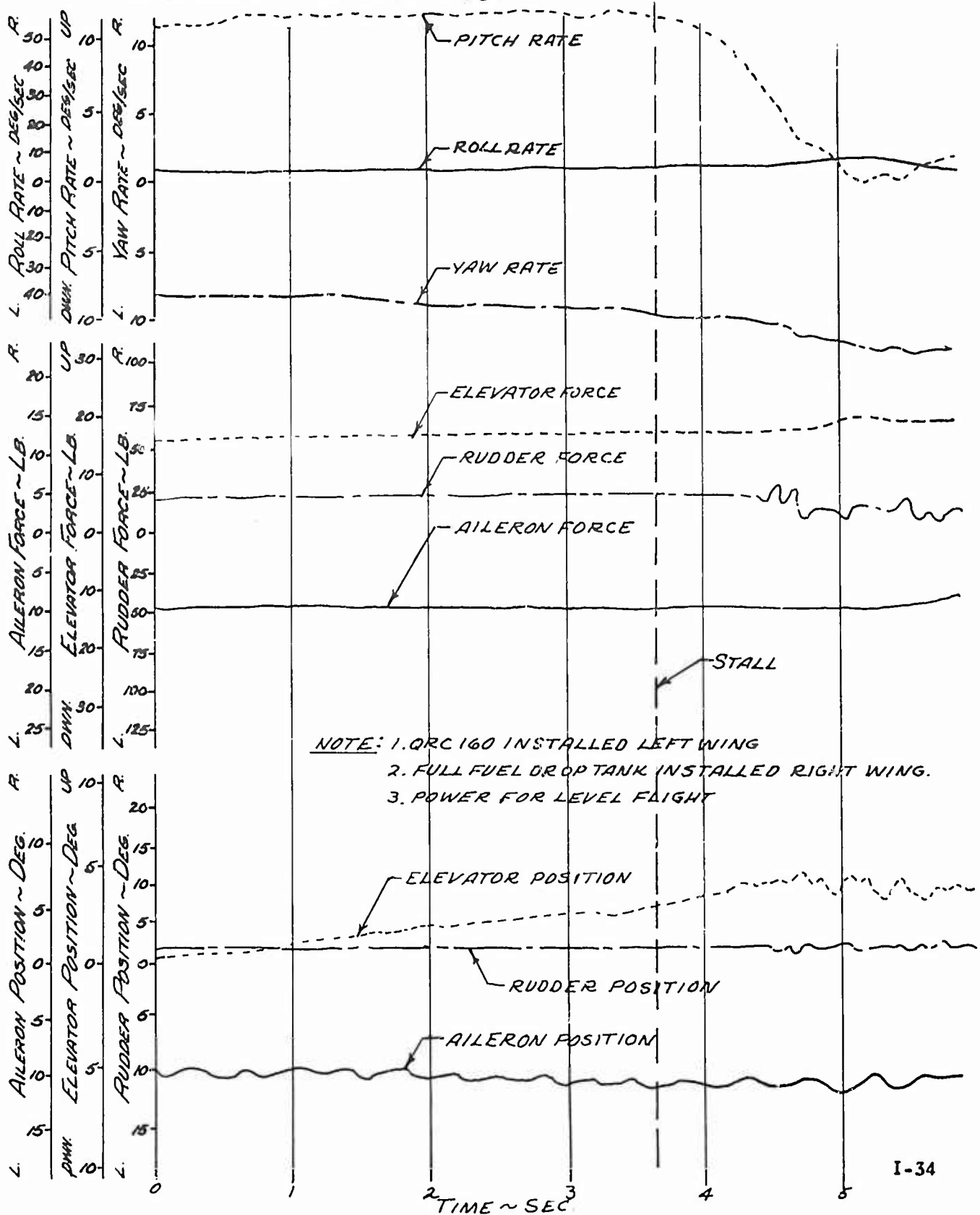
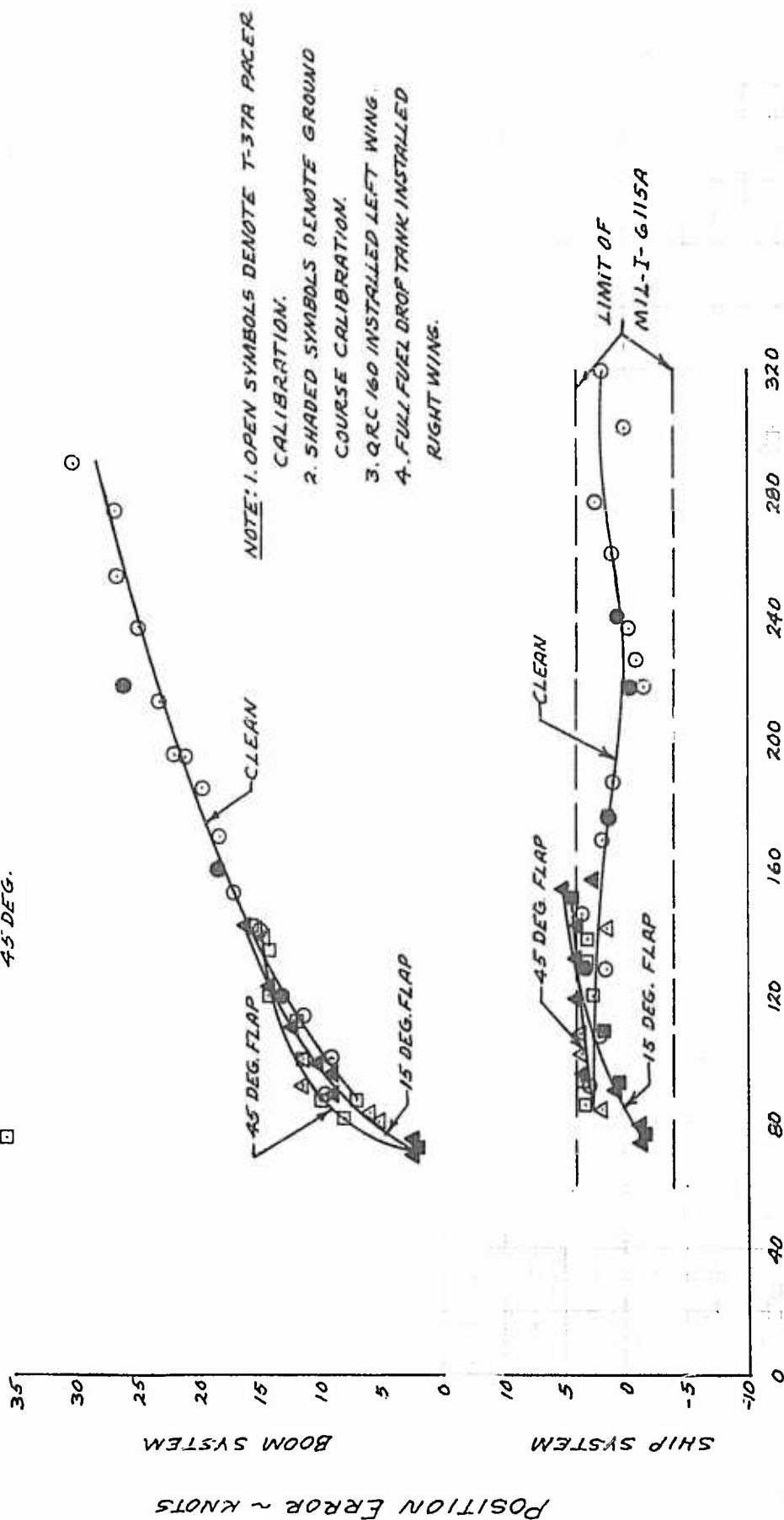


FIGURE No. 33  
AIRSPEED CALIBRATION  
OV-1C  
S/N 61-2699

SYMBOL	FLAP POSITION
○	CLEAN
△	15 DEG.
□	45 DEG.



APPENDIX II  
GENERAL AIRCRAFT INFORMATION  
Flight Limitations, Weight and Balance and Instrumentation

1.0 FLIGHT LIMITATIONS

The flight and operating limits enumerated in the Operators' and Crew Members' Manual (Reference 1.1.f) were observed during this evaluation of the QRC-160-1 installed on the OV-10.

The following limits observed during the program are of particular interest:

a. Gear and Flap Limits

- (1) Maximum airspeed with gear and flaps extended is 150 KIAS.
- (2) Maximum normal acceleration with gear and flaps extended is 2.0 g's.

b. Prohibited Maneuvers

- (1) Intentional spins.
- (2) Rolling pull-outs in turbulent air.
- (3) Abrupt control reversals.

c. Airspeed Limitations

Maximum permissible airspeed with external stores is 300 knots calibrated airspeed (KCAS).

d. Normal Acceleration Limits

- (1) The maximum positive normal acceleration at 14,000 pounds gross weight is 4.3 g's.
- (2) The maximum negative normal acceleration at 14,000 pounds gross is -1.4 g's.
- (3) Maximum permissible negative load factor varies linearly from -1.1 g's at 280 KIAS to 0 g's at maximum airspeed.

2.0 WEIGHT AND BALANCE

The test airplane was weighed and balanced in a closed hangar with empty fuel, full oil and test instrumentation installed. The results of this weight and balance were:

Basic Weight + Oil - 10,450 lb  
 Center of Gravity (C.G.) - 30.25 % MAC

The following gear-down, engine-start loading conditions were used during this evaluation. All data flights (less ballast) were loaded as follows:

Item	Weight - lb	Arm - in.
Basic Weight + Oil	10,450	164.43
2 Crew	350	61.00
Full Main Tank Fuel (297 Gal)*	1,930	161.00
QRC-160 Left Wing	196	170.00
Right Wing Drop Tank	137	162.50
Full Fuel Drop Tank (150 gal)*	975	162.50
*Fuel weight computed 6.5 lb/gal		

This loading resulted in a mid C.G. loading of:

Gross Weight - 14,038 lb  
 Center of Gravity - 27.3 % MAC

The aft C.G. was obtained by using the above loadings and adding 250 pounds of ballast in the aft cargo compartment (Station 318). This resulted in a takeoff loading condition as follows:

Gross Weight - 14,288 lb  
 Center of Gravity - 29.4 % MAC

The forward C.G. was obtained by using the basic loading and adding 341 pounds of ballast in the nose at Station 11.5. This resulted in the following takeoff loading condition:

Gross Weight - 14,379 lb  
 Center of Gravity - 23.3 % MAC

The asymmetric lateral moment obtained by loading the QRC-160-1 on the left wing fuel tank rack and a full load of fuel in the right wing drop tank was 169,460 in. - lb of right rolling moment. The asymmetric lateral moment obtained by loading the QRC-160-1 on the left wing fuel tank rack with no external stores on the right wing was 36,260 in. - lb of left rolling moment.

### 3.0 INSTRUMENTATION

3.1 The following flight test instrumentation was installed and maintained in OV-1C, S/N 61-2699, by personnel of the Logistics Division of the USAATA, Edwards AFB, California.

Recorded on a 50-channel oscillograph were:

1. Angle of Attack
2. Angle of Sideslip
3. Roll Rate
4. Yaw Rate
5. Pitch Rate
6. Longitudinal Stick Force
7. Lateral Stick Force
8. Pedal Force
9. Elevator Position
10. Rudder Position
11. Left-Hand Aileron Position
12. Flap Position
13. Center-of-Gravity Normal Accelerometer
14. Speed Brake Position
15. Pilot's and Observers' Event
16. Left and Right Power Lever Position
17. Gear Extension Signal
18. Left Wing Tip Leading Edge Accelerometer
19. Left Wing Tip Elastic Axis Accelerometer
20. Right Wing Tip Elastic Axis Accelerometer

3.2 The following sensitive, calibrated instruments were installed in the cockpit and hand-recorded by an engineering observer:

- a. Boom Airspeed
- b. Boom Altimeter
- c. Standard System Airspeed
- d. Standard System Altimeter
- e. Free Air Temperature
- f. Engine Torque Pressure (Both Engines)
- g. Exhaust Gas Temperature (Both Engines)

- h. Engine  $N_1$  Speed (Both Engines)
- i. Engine Inlet Temperatures (Both Engines)
- j. Vertical Accelerometers
- k. Oscillograph Counter
- l. Angle of Sideslip
- m. Rudder Pedal Force

Weight control was maintained by calibrating the standard ship fuel quantity indicator.

Photographs No. 4, 5 and 6, Appendix IV, show details of the instrumentation installation.

APPENDIX III  
SYMBOLS AND ABBREVIATIONS

<u>Symbol</u>	<u>Definition</u>	<u>Units</u>
KIAS	Knots Indicated Airspeed	Kts
KTAS	Knots True Airspeed	Kts
KCAS or CAS	Knots Calibrated Airspeed	Kts
C.G.	Center of Gravity	% MAC
MAC	Mean Aerodynamic Chord	In
$N_{\delta}$	Stick Fixed Neutral Point	% MAC
$N_{\delta'}$	Stick Free Neutral Point	% MAC
$C_L$	Lift Coefficient	
$\delta_E$	Elevator Deflection	
$\delta_A$	Aileron Deflection	
$\delta_R$	Rudder Deflection	
$F_e$	Elevator Force	
$F_a$	Aileron Force	
$F_r$	Rudder Force	lb
$q$	Dynamic Pressure	lb/sq ft.
$\beta$	Sideslip Angle	deg
PA	Power Approach	
TO	Takeoff	
CR	Cruise	
NRP	Normal Rated Power	

APPENDIX IV  
PHOTOGRAPHS



Photo 4 - Instrumentation - Engineer's and Pilot's Panel

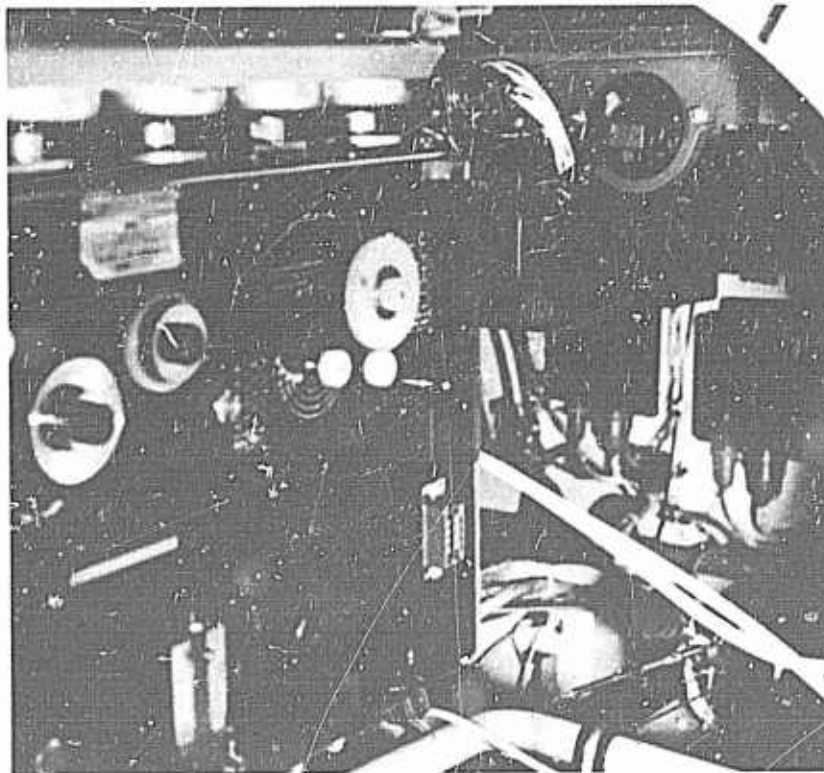


Photo 5 - Instrumentation Package

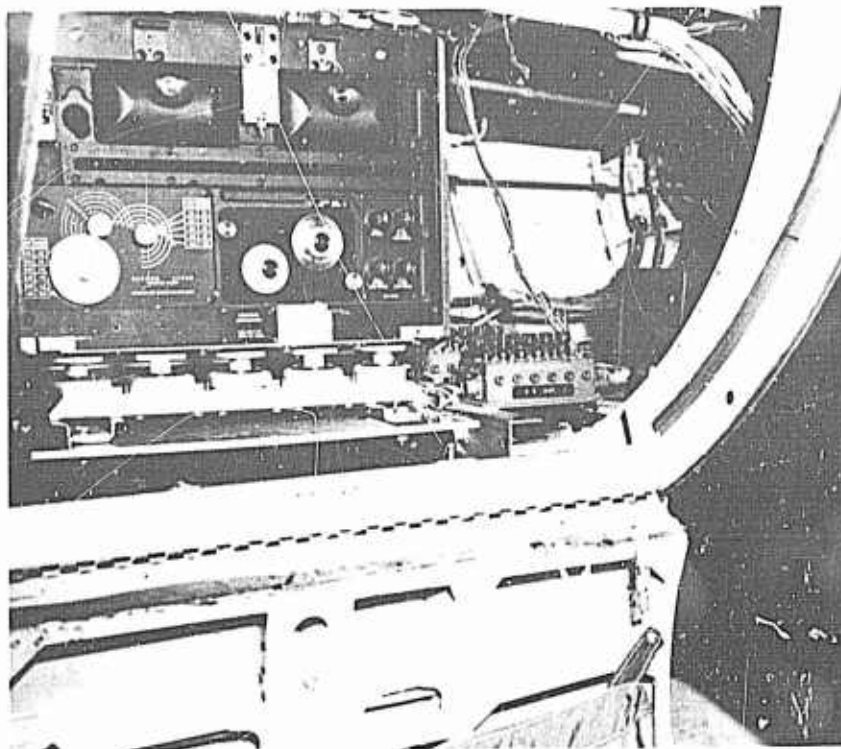


Photo 6 - Instrumentation - Recording Oscillograph

AD \_\_\_\_\_ Accession No. \_\_\_\_\_  
Final Report of USATECOM Project No. 6-3-6711-03, Airworthiness  
Certification Test of the QRC-160-1 Installed on the OV-1C  
Airplane, January 1965, DA Project No. 1-G-6-41212-D540  
(70 pp, 6 tables, 6 photographs, 33 figures)  
US Army Aviation Test Activity (USAATA)      Unclassified Report

The QRC-160-1 is an ECM External Store weighing 195 pounds used for the protection of aircraft. For this test, the installation was mounted at the drop tank station on the left wing of the OV-1C. The QRC-160-1 can be employed with safety when mounted on the left wing of the OV-1C with either a full or an empty 150-gallon drop tank mounted on the right wing provided that a restricted flight envelope is observed. The results of this evaluation concurred with the recommendation by the Naval Air Test Center of an airplane center-of-gravity (C.G.) limit of 30 percent mean aerodynamic chord (MAC) rather than the Operators' Manual limit of 33 percent MAC. Additional testing should be conducted to determine whether the lateral-directional problems uncovered during this program are inherent characteristics of OV-1C aircraft. The Operators' Manual for the OV-1C should be updated to include single-engine performance and minimum control speeds at altitudes above sea level.

AD \_\_\_\_\_ Accession No. \_\_\_\_\_  
Final Report of USATECOM Project No. 6-3-6711-03, Airworthiness  
Certification Test of the QRC-160-1 Installed on the OV-1C  
Airplane, January 1965, DA Project No. 1-G-6-41212-D540  
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